THE TERRACES OF THE TWEED VALLEY.

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SUMMARY.

This study is concerned with an analysis of terrace forms in recently glacierised areas and in particular those existing in the Tweed Valley. It attempts to establish how significant terrace fragments are as records of geomorphological evolution of an area, how easily they can be grouped and what has been the Late - and Post-Glacial history of the Tweed Valley.

A review of some of the relevant literature on other, broadly comparable areas is followed by proposals for new definitions and a new classification of terrace fragments based on surface morphology and on downvalley gradient with cross valley height relationship respectively. The limits at which down and cross valley correlation can be carried out are discussed, along with the usual interpretations laid on the terrace sequences reported in the literature. A full discussion of both the possible and the employed means of mapping and heighting terrace fragments leads to the conclusion that, for the present purposes, only mapping on a scale of 1/10,560 and accurate levelling or tacheometric survey is suitable.

As no recent account has summarised the geomorphological knowledge pertaining to the field area, the available literature has been summarised and added to in an analysis of the pre-terrace landscape elements. A detailed description of all of the mapped terrace fragments and associated fluvioglacial features is provided, arranged by splitting the Tweed Valley into three sub-areas. Virtually all of these terrace fragments were accurately heighted and the 11,000 resultant spot heights are reproduced in appendix form and also on a series of vertical linear

projection planes. The 'representative nature' of these results has been tested by taking a sample from the total number of fragments and statistically testing the variations in projected height and gradient possible by systematically excluding certain heights on a fragment. Correlation of individual fragments was carried out wherever possible, viewed in the light of distortions caused by the forms and distribution of the projection planes involved. A successful experiment involving the fitting of low order trend surfaces to individual fragments and the attempted correlation of these surfaces is reported. This employed spot heights in rectangular grid layouts on well-preserved fragments in the Fleurs Castle area. The value of steering these trend surfaces around valley meanders by changing the geographical coordinate system and the variation in trend surface form due to different point distribution patterns have also been investigated.

The terrace sequence obtained for the whole valley is markedly different to those sequences often obtained in comparable areas, particularly in other parts of the British Isles. It consists essentially of several laterally-disparate suites of high gradient, ice-proximal outwash terraces, truncated at lower levels by low gradient ice-distant outwash terraces and Post-Glacial river terraces. The upstream extremities of the high gradient forms is believed to mark the approximate positions of still-stands or readvances of the downwasting ice mass formerly occupying the Tweed Valley.

CHAPTER I

TERRACES AND TERRACE TERMINOLOGY

By supposing the order fixed and determined, when it really is not, further inquiry is prevented; and propositions are taken for granted, on the strength of a theoretical principle, that require to be ascertained by actual observation.

W.H. Fitton (1811 p.96)

A. Introduction

Valley-side terraces are among the most obvious, aesthetically attractive and apparently simple of all geomorphological features. The earliest of modern geologists and natural philosophers believed them important enough to describe in some detail. Playfair (1802 p.355) for example, commented on the appearance and location of terraces and deduced a fluvial or lacustrine origin for them. Such advanced concepts were not immediately accepted and the often vitriolic debates on these features, frequent in the early and mid-nineteenth century, can be seen as steps towards a substantiation of the principle that the most common relict terrace forms were created by rivers. However, the now-widely accepted views of Volney (1804), Hitchcock (1833), Dana (1863), Geikie (1865), Greenwood (1866) and many others were long challenged by such workers as Hayes (1839) and Chambers (1848), who upheld a marine origin for most of the features.

Even within those advocating a fluvial origin for terraces at this time, a marked divergence of opinion existed. While many believed the features to have been formed by rivers existing in the geological past at higher levels than at present (Playfair 1802, Dana 1863), others reiterated that such forms were caused by deposition during the enlargement of present rivers while in flood (Tylor 1868, Brown 1870). Observations on the phenomenal power of flood waters and the great increase in river levels possible, such as the values quoted by Dick Lauder (1830) for the Moray floods of 1829, were often used as arguments for such an explanation of terrace origin.

The growth of knowledge was such that, by the turn of the century, few of these heretics remained. Publication of Penck and Bruckner's 'Die Alpen im Eiszeitalter' in 1909, in which terraced valley trains were used as indicators of glacial limits, combined with the work of Commont (1910) and de Lamothe (1918) on the Somme benches and terraces, the latter used as indicators of previous sea levels, gave a great impetus to fluvial terrace studies. Acceptance of these uses of terraces spread rapidly through many parts of the world, in particular the Mediterranean Basin, Britain, Germany, North America and New Zealand.

The basis of the correlations of terrace fragments in many of the resulting studies was altitude of the surface, usually unqualified by position on the fragment, obtained with a basically unreliable device and interpreted in terms of the preconceptions derived from probably valid studies in other areas. The widespread uncritical application of an idea developed in other areas is typified by a paper by Rice (1957). His terrace heights are "computed from information contained on the Ordnance Survey 1/25,000 and 6 inch maps" (p.224) and are taken to show four relict terraces streaming from "knickpoints" even though these terraces are separated by vertical amounts ranging from only four to fifteen feet. It may be that the interpretation is correct but if so, in so far as it is based on terrace height, this is fortuitous.

The main tenet of this thesis is that such misapplications of preconceptions and neglect of vital assumptions have been widespread in the field of terrace studies and have contributed to a frequent, if not invariable, laxity in critical examination of terraces by geomorphologists. An analogy can be taken from the widespread acceptance of the 100,50 and 25 foot raised beach model for Scotland, despite the longstanding availability of evidence discrediting it. Only in the last six years, with the use by Sissons (1962,1966) and co-workers of accurate altimetric and other techniques, has it been shown that the raised beach sequence is in fact a series of tilted beaches, decreasing in gradient with decreasing age. Solely by applying equally detailed measurement to terraces can it be shown if many of the anomalies in the present knowledge are due (as suspected) to limitations of the crude techniques previously employed, or if there are indeed aspects of terrace development which render accurate measurements futile or merely unnecessary. Thus the aim of this thesis is to examine one aspect of terraces in greater detail than has been done in the past in an attempt to resolve at least some of the superficialities inherent in many previous treatments of the topic.

Two important qualifications must be made at the outset. The first of these is ubiquitous in that all scientific inquiry is constrained by the same limits. No scientist can undertake to provide the absolutely correct answer or, in this case, state with complete certainty how and when the terrace features were formed. All that can be expected is the simplest internally consistent explanation in the light of the data available and the existing framework of theory. Reality is only one of many possible situations that could have occurred and without total information, much of which has now disappeared with the formation of younger features, the best statement possible will still be an approximation to reality. While it is hoped that this study will enable a much closer approximation to be made than hitherto, the overriding concern and the only means in which this improvement in accuracy can be provided, is in ensuring internal consistency in the interpretation of the data.

The second qualification is that the field work was carried out inside an area last deglacierised probably between ten and twenty thousand years ago. Both in terms of preservation of small remnants and variation in original form, the terrace sequence could be reasonably expected to be more complex than in an area far removed from glacial and periglacial processes in Pleistocene times. Set against this, however, is the longevity of existence of many terraces in extra-glaciated areas, a factor permitting much greater post-formational modifications to the surface. Thus, strictly, the conclusions derived from this study are applicable only in areas comparable with the Tweed basin. Yet, as the methods employed are generally more accurate than have been used to date, they at least are immediately applicable to extra-glaciated regions.

B. A Definition of Terms

In part due to the lengthy period through which discussion on terraces has been active, but also owing to the various disciplines in which workers on these features have been trained, the terminology used to define the term 'terrace' has varied greatly. Thus Leopold, Wolman and Miller (1964 p.458-60) took as their definition of a terrace "an abandoned flood plain .... an abandoned surface not related to the present stream". Evidence will be presented later to show that in the Tweed basin certain factors make it impossible to accept the rider that the terrace must be unrelated to the present stream. Another variation of the definition of 'terrace' was implicitly used by Clapperton (1967 p.229) who, in saying that "..... the Milfield terrace is therefore considered to be a delta deposit", employed the term to refer both to a surface and the underlying stratigraphy.

The working definition utilised throughout this study can be summarised by describing a terrace fragment as an approximately laminar and horizontal or gently inclined surface, surrounded by perceptibly steeper slopes and located within a valley. Three possible variations of terrace form, all of which occur in the Tweed Valley, are illustrated in figure 1.1. This definition is entirely based on terrace morphology, genetic and other descriptive prefixes being added only after the analysis of field data was complete for any section of the entire field area. It concentrates on one, albeit usually the most important part of other terrace definitions, the upward facing surface. A terrace is defined as a large terrace fragment or a combination of approximately synchronous fragments arrived at after correlation. Chiefly to add variety to the text, the terms 'terrace remnant' and 'flat' will be used as synonyms of terrace fragment.

Leopold, Wolman and Miller (1964 p.460) included the frontal (or river edge) scarp as part of the terrace. Yet, as Davis pointed out as long ago as 1909, the largest part of this scarp was probably cut lon after the formation of the upward facing surface. It is as illogical to include the front or the back scarp (as Davis advocated) in the terrace definition as it is, say, to assume the contemporaneity of terraces and man-made features on them: the ages of the different landscape elements may not be significantly different but this depends on the boundaries of significance as much as on the actual ages.

This can be illustrated crudely by regarding the inter-terrace slopes as the vertical axis of a graph whose X axis is downvalley distance and Y axis is time as well as height above the present river.

Implicit in the above statement is that the terrace or upward facing surface is a synchronous feature throughout. This may be a crude simplification of reality as such features can be formed by a meandering river engaged in slow, continuous vertical and lateral corrosion, leading to an apparently continuous and regular single surface which is markedly diachronous across and probably down valley. This will be discussed in more detail in a later section but initially it will be assumed that single terrace fragments are broadly synchronous, without specifying limits to this range of synchroneity.

This new definition of a terrace must be adhered to spatially and temporally. Its adoption, therefore, has at least two important implications: the first of these is that the flood plain is a terrace when classified on morphological grounds. That this is a sensible use of the term terrace is clear from the graphed results of terrace altitudes, where the difficulties of discriminating between present day and low gradient relict features are often obvious. Thus the use of 'floodplain' in this study should be taken to be a summary of 'the terrace adjacent to the present river and believed to be in the process of formation at present'.

The second implication following from the present definition of a terrace is that such features can have been formed in a number of ways. A flat surface of till is termed a terrace if suitably located. It was therefore found advisable in the early stages of field work to employ a non-genetic basis for the description of features. The width of the limits set for the term terrace is largely a function of the field area; as the Tweed Valley contains few sections, non-fluvial or non-lacustrine forms could only rarely be excluded from the study at the mapping stage.

The use of 'terrace' to include or to mean surficial deposits or bedrock, as by Clapperton (1967) is widespread. Surficial materials will henceforth be entitled terrasiform deposits where the surface is a terrace, following the use of the term by R. Chambers (1849). In the present study, only qualitative relationships can be expressed between terrasiform and nearby non-terrasiform deposits as correlation is essentially based on a single variable, terrace altitude and its rate of change, terrace gradient. No terraces or terrace fragments entirely underlain by rock are known to exist within the field area.

'Crossing terraces' will be used throughout to denote terraces of differing downvalley gradient which intersect along a line when seen in plan. In the normal situation, the lower gradient flat is probably the younger feature, burying the older relict form downvalley from the line of intersection. The term 'terrace rim' refers to the front (river) edge of the terrace, owing its present location in most cases to post formational erosion of the materials underlying the terrace. Definitions of the terms used to describe glacial and fluvioglacial features are those given by Flint (1957).

C. The Classification of Terraces and Terrace Fragments

The basis of all scientific interpretations of experimental data is a classification scheme; objects are ordered into some kind of groupings about which meaningful statements can be made. As Bronowski (1960 p.54) said "Order is the selection of one set of appearances rather than another because it gives a better sense of the reality behind the appearances". Unfortunately, previous terrace classifications, in design and use, show the varied beliefs or preconceptions of field workers on what are orderly or significant groupings. Frequently, where the data has been inadequate, preconceptions of what should be found have been virtually the sole cause of the interpretations made. Thus Bryan and Ray (1940) compiled a diagram (p.40) of six near-parallel, extremely low and constant gradient valley trains, seperated only by ten to twenty feet and bearing little relation to the scatter of heighted points shown.

A variety of classification schemes already exists. Bearing in mind that other workers have often taken different definitions of the term terrace, at least nine criteria have been used in the past for the subdivision of terrace types. These are set out below, together with examples from the literature in which they appear and of the terminology employed. Deceptively, this classification of terrace classification criteria is not as clear-cut as it may seem, owing to the occasional use of individual prefixes to indicate several properties of the terrace.

Dividing criterion	Example of terrace type	Example from literature
1. Immediate origin	river)	Wills(1938)
	outwash) terraces	Stephens & Synge(1966)
	lakefloor)	Flint(1957)
2. Mechanism of Formation	aggradational) terraces	Speight(1907)
	degradational)	Fisk(1939)
3. Changes leading to Formation	eustatic)	Wooldridge & Linton(1955)
	thalassostatic) terraces	
	tectonic)	Zeuner(1959)

4. Reason for preservation or non-preservation	rock defended) polygenetic) terraces	Davis(1909) Chaput(1930)
5. Long profile form	concordant) discordant) terraces	Briquet, quoted in Davis(1910) Thornbury(1954)
6. Cross profile form	glacis terraces	Hitchcock(1833)
7. Cross valley height relationship	paired) unpaired) terraces composite)	Cotton(1940)
8. Position within valley	ampthitheatre) slip off) terraces	Miller(1883)
9. Lithology or stratigraphy underlying terrace	strath) gravel) terraces	Leopold, Wolman and Miller(1964) Docherty(1967)

D. A New Classification of Terrace Fragments

With such a multiplicity of terminology, some current, some defunct, much of dubious value and most compounded in a period when terrace studies were largely restricted to observation alone, rather than that allied with measurement of supposedly significant properties, it seemed best to devise a simple new classification. This is presented in figure 1.2 and is intended solely for determination of terrace fragment origin by altimetric means. It may, however, also be used for the determination of the origin of terraces, after the initial terrace fragment correlation is complete. While there is no justification for change of classification on the pretext of boredom with that which is currently accepted, the dates at which most of the terms listed above appeared in the literature reflect the fossilisation of terminology which, indicative of a lack of continuing reassessment, exists in terrace studies. What Toulmin (1962 p.51) said of the physical sciences: "reclassification of subject matter in the light of discovery is the rule" must also apply to a subject in which relatively little reliable work has been carried out on regional variations in terrace properties but in which the phenomena are believed to appear only in certain circumstances and thus obey scientific laws.

Griggs (1965,1966) pointed out that classifications can not be expected to last indefinitely and also that it is best to devise them, where possible, to suit the purpose of the study. Further, he suggested that in the ideal case, the principle on which the logical division takes place should be the same throughout the scheme. The new classification, illustrated in this case by the use of a flow diagram, was designed with these essentials in mind and two aspects of the height of terraces, gradient and cross valley height equality or inequality, have been selected for the two stage breakdown.

In such a simple classification based on one variable, a certain amount of ambiguity is unavoidable; unpaired solifluction terrace fragments may have identical gradient properties to kame terrace remnants over short down valley distances. Such ambiguities have to be resolved by recourse to examination of other properties of a terrace, such as the sub-surface stratigraphy. The final stage in the new classification is comparison of the origin deduced from altimetric evidence with all alternative information.

Many other important qualifications and explanations are needed before use of the scheme is possible. Most important of these is that this classification, although based on values from terrace forms manifestly in the process of formation at present, in various parts of the world, was designed for the Tweed Valley conditions and modified when, by comparison with reality as perceived in the course of field-work, serious anomalies appeared. No claims of universality are made for it. All the genetic prefixes refer to the agent believed responsible for the largest percentage of the surface form as it exists at present.

Except where otherwise stated, all gradients mentioned are those in a downvalley direction. The prefix 'simple', when used in association with gradient in this scheme, is taken to mean uni-directional. Complex gradients are multi-directional forms as might be found when heighting across a tributary valley alluvial fan. A positive gradient implies a reduction in terrace altitude downvalley while negative gradient is used in the converse case. The term 'regular' is an important qualification as it will be assumed initially that if a terrace fragment is of this form, it is of near-constant slope, is significant and can usefully be heighted. (This is discussed at greater length in the section on the significance of terrace fragments).

Chance terrace remnants are those due to isolation by post formational erosion of near-flat surfaces of till, apparently unrelated to any base level and found to have been formed independently of fluvial, lacustrine or marine processes. The term 'pseudo terraces', used by Peel (1941) for the same features is inapplicable where (as in this case) the terrace itself is defined solely on surface morphology. Where possible, prefixes were chosen so as to be mutually exclusive but in many cases this was impossible. Kame terrace fragment, for example, is only one subdivision of fluvial forms. Thus fluvial is used as a prefix embracing both ice-proximal glacial outwash and ice-distant river-formed terrace remnants. The frequently misused but convenient term 'river terraces' will be used for the latter category, despite the misleading inference that ice-proximal outwash forms are not therefore river-formed.

In designing a system such as this, it is essential to leave a 'dustbin' category - one into which those forms that cannot be explained by the present classification can fall and act as feedback, leading to modification of the scheme. Likewise, good system design must always cater for the non-appearance of features. Fluvial terraces existing on one side of a valley and not on the other can be due to the occurrence of originally unpaired forms or to post-depositional erosion of paired forms. Allowance must also be made for the possibility of miscorrelation at every stage where the scheme is being used for deducing the origin of terraces as opposed to terrace fragments.

Many previous classifications in design and in use have considered the sub-surface stratigraphy of terraces and terrace fragments (e.g. Fisk 1939, Cotton 1940). As no attempt was made to obtain the stratigraphy under every terrace remnant,there being few natural or man-made sections in the Tweed Valley while borehole information is sparse, subdivision on this criterion was impossible. Further, some of the sections under terraces that were observed showed the surface to have a marked indifference to subsurface lithology. An example near Sprouston, Kelso, showed no surface reflection of a sudden change in the underlying near-surface geology from unconsolidated sand and gravel to basaltic lavas.

Essentially this classification scheme is extremely simple, being based on the principle that down valley gradients of ice-proximal outwash will be steep, those of river terraces much less so, while lacustrine features should be near horizontal and those fluvial forms relating to tributary valleys should be complex in form. While this is unlikely to be controversial, the numerical values on which the genetic prefixes are assigned are a matter of the utmost importance and must be justified.

Present day lake shorelines in relatively stable areas appear to be sensibly horizontal. Similar relict forms are known from areas such as Glen Roy (MacCulloch 1817, Milne Home 1849, Jamieson 1863), presumably near to the centre of isostatic uplift. Ice - marginal lakes are widely accepted as having initially near-horizontal shorelines (Sissons 1967 p.114) while lake bed deposits, except in marginal areas, could be expected to show approximately horizontal surfaces if undisturbed. Examples of features which might occur in association with a lake in an area such as the Tweed Basin are subaquatic deltas, isostatically tilted bottom or marginal forms or greatly eroded flats which were originally horizontal.

What little is known of isostatic effects in the field area is derived from the detailed work on raised shorelines in the Forth estuary by Sissons and his co-workers. The maximal gradients yet obtained are of the order of 6.7 feet per mile from the pre-Perth Readvance beaches of Eastern Fife. The isobases at present available

(Sissons 1965, Smith, Sissons and Cullingford 1969, in press) show that the removal of Highland ice may have had a marked effect on the down valley gradient of lacustrine flats in the Tweed Valley if the area was not entirely ice-covered at the time. Examples of isostatically deformed lake shorelines are common in parts of the United States, Canada and Scandanavia. Thus, although the amount of readjustment in the field area in response to the removal of Southern Uplands ice is unknown, the category limits for lacustrine features must be fixed in the light of this, possibly increasing the maximal 'isostatic gradient' to about 10 feet per mile. To include these possibilities, a downvalley gradient category of 0 to +10 feet per mile was accepted for the definition of lacustrine flats.

Glacial outwash in valley train form usually grades down valley from steep, ice proximal sections with braided stream patterns to gently sloping flood plains, often with a uni-channel stream pattern. The lower limit of 50 feet per mile for ice-proximal outwash terrace fragments was chosen on the basis of known gradients on present day outwash of between 80 and 100 feet permile over a distance of 1600 yards from the ice front in Iceland (pers. comm. P. Howarth) and from values in the literature, such as that given by Tarr and Martin (1912) of 73 feetper mile. Flint (1957 p.136) gives values of 26 to 52 feet per mile or more as common for the surface of outwash, without specifically providing values for the ice-proximal variety.

By spot checks on the present-day Tweed gradient, the limiting values for the river terrace category were set as 0 to 50 feet per mile. Some degree of overlap of the category limits, illustrated in figure 1.2, is unavoidable and where a fragment's gradient falls in this range, its origin can not be unambiguously specified unless additional evidence is available for clarification of the genesis of the surface. For all the categories discussed to date, regular, simple and positive gradients are pre-requisites before any analysis of the value of a terrace fragment gradient can be carried out.

Considerable regional variation exists in the ease in and confidence with which fragments can thus be assigned an origin on altimetric grounds. Distinguishing between lacustrine and fluvial forms is easy in the higher reaches of a river valley but much more difficult in the lower reaches where gradients of remnants are usually small. Conversely, it is usually quite easy to distinguish between ice proximal outwash and river terraces near the river mouth, but much more difficult to separate the two features near the head-waters where the present river gradient may approach that of ice proximal outwash. The optimal solution, therefore, is to employ a classification, the category limits of which are on a sliding scale, varying with position of the fragment within the valley. However, the vast amount of empirical work necessary for setting up of such a classification and the yield of only regionally significant results ensure that such a scheme would be no more than an academic exercise.

The frequency of the appearance of the prefix 'solifluction' in the classification is both an indication of the variation in form believed to be possible in this category and also of the lack of quantitative information existing on solifluction terraces. The hypothetical possibilities are numerous, including the veneering of a pre-existing terrace fragment and retention of its gradient. The single element of surface morphology found most useful in elimination of such a periglacial origin is the cross valley profile of each fragment where this declines from front to back of the terrace and has the appearance of an original form, rather than being the result of post-depositional erosion, solifluction is unlikely to have been responsible for the surface, unless originating on the other side of the valley. Such a form, sloping away from the long axis of the valley, is most likely to be the surface expression of glacial outwash or a flood plain.

Numerous subdivisions of a subglacial origin for terrace remnants are also suggested in the classification scheme. In part this reflects a belief that submarginal ice tunnel deposits could form terrace fragments of limited extent even after frontal slumping. Indeed, Hoppe (1963) and others have suggested that much larger flats may be formed by subglacial sedimentation and the suggestion by Price (1961) that certain terrasiform deposits in the Upper Tweed might been formed under ice is sufficient to justify the multiplicity of categories. The lack of quantitative knowledge of the surface morphology of subglacial sediments has resulted in the category boundaries being built up on theory and on the properties of subglacial streams culled from other field work and the literature. It is possible that many other forms with gradient and surface expression already assigned a proglacial origin may in fact have been formed under ice. The policy in this thesis, however, will be to take the simpler and more conventional alternative where a choice exists if no other evidence of subglacial deposition is present.

Terrace fragment gradient on its own is rarely an entirely satisfactory indicator of origin. A study such as the present one, partly normative in concept, is justifiable on the grounds of insufficient alternative evidence and also on the basis of being an experiment, rather than a mere application of widely proven techniques in an untouched area. Even so, no opportunity of checking or refining results should be lost and the analysis of the significance of each fragment and also of the form of the terrace long profile executed after all possible correlation of the fragments is complete, gives valuable additional evidence of origin to that provided by use of the new interpretative classification scheme.

E. The Significance of a Terrace Fragment

All the heights presented in appendix 1(a) and in graphical form in this thesis were collected on the fundamental assumption that the terrace fragment, a surface flat, is significant, in that a close relationship exists between its present form and the processes responsible for its original form and subsequent change of level in relation to the present stream. Furthermore, it was assumed that the vast majority of the remnants were formed very largely by one group of processes rather than another, say fluvial rather than periglacial. While slight modifications to this latter assumption are now possible in the light of field observations, the basic principle of a univariate explanation of terrace fragment form must be adhered to, principally because of a lack of non-altimetric data. Two situations exist in which a flat may not be amenable to such explanation: where composite features occur or where there is ambiguity of interpretation through what Chisholm (1967) has termed equifinality of form (see below).

It is probably safe to assume that positive regular forms are non-composite. While terrasiform deposits very frequently indicate a multivariate origin (e.g. Wills 1924 p.294) the surface itself is likely to be solely a result of the most recently active agent of erosion or deposition. Exceptions to this are easily conceived but are usually equally obvious in the field as multiple forms. An example of such a composite form might occur when a river engaged in slow vertical corrosion forms a meander slowly shifting down valley; the successive terraces formed on the inside upstream side of the meander would appear as a series of descending steps. Where the downcutting tends to be continuous, these steps tend towards the limiting case of a continuous slope, diachronous but labelled a polygenetic terrace by Chaput (1930). Even if this limiting case were never attained, erosion at the terrace front and deposition at the back of the lower flat would tend towards smoothing of the steps into a composite diachronous plane.

Greater difficulty is experienced in dealing with irregular features in that such forms may require a univariate, or a multivariate explanation. Frye and Leonard (1954) suggested that terrace long profiles could be markedly complex, perhaps sigmoidal in form, and it is quite reasonable to extend this to terrace fragments. Cases of outwash fans superimposed on bedrock with a marked angular break at the junction are common in the Scottish Highlands and it seems that in some instances the terraces cut in the fan and occasionally in the rock downstream from the junction are contemporaneous. Such irregular long profiles could be explained in a univariate fashion while a morphologically identical, composite feature formed by crossing terraces may require a multivariate solution. This is an example of equifinality of form of irregular features. Composite forms only exist as a small percentage of all the terrace fragments in the Tweed Valley; wherever they were found, further investigation was carried out.

The greatest difficulty is experienced in dealing with surfaces of a multivariate origin but having a regular downvalley profile. Indeed, it has already been accepted that features with such a regular profile are probably non-composite and it would appear impossible to distinguish such landforms on the basis of surface altitude alone. Apart from an examination of the stratigraphy of the terrasiform deposits, an analysis of surface roughness can, however, be a good guide to whether a fragment is essentially due to one factor or whether a multivariate solution may be necessary.

Although often indistinguishable on higher and older terrace remnants, two types of surface roughness exist and techniques are currently available for their measurement and quantitative expression, (Hobson 1967). Secondary roughness, caused by channels dissecting the flat, following a change of base level or some other controlling factor, is of little help except that on a statistical basis it might be possible to correlate near-synchronous large terrace fragments over considerable areas by devising a hierachical scheme of the state of surface dissection.

Primary surface roughness, where it can safely be recognised, is of much greater value. The presence of point bars, channel bars, cut off channels, levees, channel fill or other morphological elements of the floodplain immediately excludes many of the ambiguities listed in certain sections of the classification. Furthermore, the remains of a relict braided pattern might be related to the heavily aggrading conditions of ice-proximal outwash, although this is far from being the only situation in which braiding occurs (Leopold, Wolman and Miller 1964 p.294). The existence of kettle holes in terrasiform deposits is another example of the value primary structures can have on assignation of terrace fragment origin.

Nevertheless, a lack of any of these primary structures does not exclude any of the origins with which they are usually associated. Post-formational modification by flood waters is an important possible factor in creating terrace fragment form, often removing primary roughness without materially altering the overall gradient. Hoyt and Langbein's (1955) book on floods contains examples of the prolific changes that can be wrought on natural features, such as terraces, in very short time intervals while Learmonth (1950) described the effects of the last major flood in the Tweed Valley. Here much gravel was deposited on some low terraces while others suffered greatly from scouring.

In summary, it is believed that terrace fragments of regular positive downvalley gradient, at least in the Tweed Valley, are extremely unlikely to be composite features. All remnants that showed marked irregularities in the long profile were re-examined. Only if two entirely different forms of primary surface roughness are present can a multivariate origin for any single fragment be postulated when no evidence is available from the underlying stratigraphy.

CHAPTER 2.

TERRACE FRAGMENT CORRELATION AND INTERPRETATION OF CROSS AND LONG PROFILES IN THE LITERATURE

A. The Value of Correlation.

Successful correlation of terrace fragments has two major benefits for historical geomorphologists. The first of these, already noted, is the higher degree of certainty that can be attached to the origin of any one fragment when viewed as part of an entire downvalley sequence, rather than in isolation. Allied to this, but even more important, is the interpretation of landscape evolution and sea level change it is sometimes possible to make from a complete terrace sequence.

B. The Meaning and Techniques of Correlation.

All terrace fragment and terrasiform deposit correlations known to the author are on the basis of supposed synchroneity. Correlation by any means largely depends on selecting an indicator that changes regularly in value throughout time and space. Thus a parameter, say heavy mineral content, which had a hierarchical distribution throughout space would be of little value in correlating supposed synchronous terrasiform deposits. Gross variations between two adjacent fragments could be due either to age difference or position in relation to the breaks in the parameter distribution continuum.

An inference common in much of the literature is that the periods of fluvial terrace formation by, say, aggradation are separated by substantial intervening periods when dissection occurred and thus the terraces can be looked on as synchronous throughout their areal extent. The work of Fahnestock (1963) and others on the work of glacial streams emphasises that at least in formerly glaciated areas, the intervening periods between terrace fragments separated vertically by up to about ten metres might be very small in comparison with the variation in time represented by the aggradational surface. Thus, strictly, it is more realistic in such areas to correlate on the basis of 'river vertical position', a loosely time-based concept, rather than strictly on synchroneity of surfaces formed over varying but sometimes considerable periods.

Numerous means of relative and absolute dating as correlation indicators have been used in terrace studies apart from height. These include considerations of the type of fossil fauna and flora, of the concentration, variations and stage of decomposition of heavy and light minerals in and the erratic content of the underlying terrasiform deposit. The presence of buried soil horizons within the sub-surface stratigraphy or solifluction deposits on top of it, aided where possible by C14 dating of organic remains, is usually of considerable value in correlative studies. Detailed examination of particle size and shape has been utilised by Tricart (1961) and others while Martin (1963) utilised radio activity counts from fluvioglacial deposits as a means of correlation. Jamkhindikour's (1967) successful use of Differential Thermal Analysis of the clay minerals in terrasiform deposits revealed different types to exist under floodplains and terraces. Where this can be shown to be due mainly to age differences rather than drainage, topographic or source area variations, D.T.A. could be used to provide another correlation indicator.

All indicators have inherent limitations; their misuse may have occurred quite frequently as it seems little concern has been felt over sampling techniques and, in particular, operator bias leading to sampling error. With the notable exception of Tricart and his co-workers, many scientists studying large scale spatial variations in the parameter used as a correlation indicator have neglected to measure the small scale, local variations. If both are of the same order of magnitude, the indicator is probably an unsuitable one.

C(i) Cross Valley Correlation by Height

Terrace fragments have always been correlated, at least by height, in an orthogonal sense, across and down valley. Three possible combinations of cross valley height relationships have been postulated, forming paired, unpaired and composite terrace sequences. Cotton (1940) implied all have been found.

This classification is a convenient simplification, ignoring the effects of heighting in different places on a terrace fragment's cross profile, noted in Chapter 3 . For the moment, however, the term 'paired' will be retained and used to embrace those terrace remnants whose heights lie within a specified range, separated by a cross valley distance less than a certain value. Values for the range and maximal distance will be discussed later. Unpaired terraces are those in which the difference in surface heights exceeds an acceptable value while composite sequences contain both paired and unpaired terraces.

To the author's knowledge, no discussion of the limits of the range of heights between paired terraces has been published. All previous correlations have been based on visual inspection, bearing in mind intuitively sensed limits. Although full discussion of this topic must await the evaluation of results gathered in this thesis and set out in a later chapter, the limits being essentially a function of vertical terrace spacing, valley width and slope and state of dissection of the fragment, it seems possible to make a provisional limitation at the outset. This is that such remnants can certainly be considered as paired and therefore possibly near-synchronous if the height variations on either terrace [1] are greater than the difference between the median heights of the two flats. Surface height variations due to obvious secondary erosional features are naturally excluded from this definition. To corrupt the terminology of Montefiore and Williams (1954), this is a sufficient reason for calling terraces paired in form, but not a necessary one. Conversely, to be able to separate two remnants as unpaired terraces, the minimal requirement is that the vertical height difference between them should be greater than the 'noise' on either surface.

C(ii) Conclusions derived from Cross Valley Correlation

The implications of deciding that two fluvial terrace fragments are paired, assuming no miscorrelation has occurred and taking the simplest possible case are that episodic still-stands of the vertical component of river erosion and deposition have occurred, separated by periods of downcutting. It is possible, however, that paired terraces could represent entirely different sequences of landscape evolution. Flats related primarily to tributary valleys and subsequently slightly modified by subaerial processes might

1. Local terrace height variations at this scale are considered as noise. Loudon (1967 p.13) discussed the variations in form of a surface with changes in scale of viewing.

coincidentally fall within the specified height range. Paired lacustrine or estuarine terraces indicate there has been no substantial earth displacements in a cross valley direction since the time of terrace formation, unless the displacement has been such that the n^{th} terrace on one side of a valley now corresponds exactly with the $(n + j)^{th}$ terrace on the other. Other types of paired terraces are more difficult to interpret and additional evidence, usually stratigraphic, is often required.

Unpaired fluvial terraces have generally been taken to indicate continuous or near-continuous downcutting in the area in which they occur (Challinor 1932) but it should be noted that episodic still-stands and intervening down cutting could have occurred but cannot be proved at that point owing to the destruction of the evidence by post-formational erosion. Where a river has concentrated its action at one side of a valley it is unrealistic to expect a fully paired sequence, even if pulsatory downcutting occurred. Most diagrams in standard texts illustrating the formation of terraces grossly simplify the issues involved by inserting the river at a near symmetrical point. Furthermore, at any one location, several possible sequences of terrace evolution may exist as represented by terrace form. Complex theoretical cross valley stratigraphic sequences underlying simple surface morphology have been described by von Wissman (1952), Leopold, Wolman and Miller (1964) and others. Some of the possible variations are shown in figure 2.1, modified from Leopold, Wolman and Miller (1964) p.460.

The classical explanation of composite profiles is that this is a simple mixture of paired and unpaired terraces, representing terrace formation in periods of episodic stillstand and also during slow but continuous downcutting by the river.

D(i) Down Valley Correlation by Height

The down valley correlation of morphological flats and the interpretation of the resultant long profile is a matter of some controversy. Such correlation of similar stage fragments is essentially different to normal attempts at cross valley correlation except where quasi-horizontal, say lacustrine, features are involved. This is because the vast majority of terrace fragments are probably fluvial in origin and thus the essential problem is of correlating two sloping surfaces. Down valley correlation of terrace fragments depends on the original features being formed by aggradation or erosion during a stillstand, a time during which all the parameters affecting the terrace height and gradient remained a proximately constant,or on the river being very much constricted to the centre of the valley for considerable downvalley distances as it continues to cut down and also diminish in volume. In most cases, this correlation is attempted between two or often many more sloping fragments and in the past has almost invariably been carried out by visual inspection.

Two elements are concerned in the correlation of single lines of heights on fragments of terraces. Variation in gradient (OB/OA in figure 2.2) and Y or X axis intercept when projected (OB and OA in figure 2.2) or a combination of both of these must be considered. Figure 2.2 also illustrates good and bad fit between two terrace fragments. There seems to be no reason why criteria, empirical at least, should not be formulated for defining whether two fragments are, within a certain statistical error, part of the same curve or straight line. In essence this is what visual inspection has always done, albeit on subjective grounds.

Limitations of this quantitative panacea are the effects of the orientation of the plane into which the heights are projected, as this can markedly affect downvalley gradient: this subject is fully discussed in Chapter 8. A fundamental assumption in this and in visual inspection-correlation is that terraces, viewed in downvalley profile, are fairly smooth in form, possessing no marked irregulatities. It will be shown that this assumption is not always justified and thus even the more sophisticated techniques available for correlation of terrace fragments need to be used with caution.

D(ii) The form of Present River Thalwegs

As a large percentage of terraces is probably fluvial in origin, being relict floodplains, and as floodplains are approximately parallel to the rivers which are responsible for their formation, an examination of the factors influencing the long profile of a river is a prerequisite to discussing the implications of reconstructed terrace long profiles.

Since the publication by Hack in 1957 of his important paper on longitudinal profiles of streams in Virginia and Maryland, much more data has become available to aid the analysis of factors responsible for the forms of river profiles. Leopold, Wolman and Miller (1964 p.251) believe the primary factors influencing the long profile of a river channel and thus the water surface (on anything but a very small scale) are discharge, load delivered to the channel, size of debris, flow resistance, velocity, width, depth, slope and base level. Some of these are semidependent, some are independent and the others are dependent variables; in certain cases, some e.g. river gradient, may be considered semi-dependent while usually dependent variables. The evolution of a theoretical form for a river long profile is exceedingly complex. Recently it has been studied in new ways, with promising results. Leopold and Langbein (1962), by regarding a river system in terms of its initial potential energy (due to rainfall) which is converted into the kinetic energy of flowing water and dissipated by friction, pointed out a close analogy with the thermodynamics of systems in a steady state. Using an existing body of knowledge and assumptions of a most probable distribution of variables, solutions were derived which could be compared with the actual hydraulic geometry of rivers.

Of all rivers, those in recently glaciated areas are probably the most difficult to analyse in quantitative terms. Frequently the river does not run on rock but in a valley deeply infilled with material whose grainsize is heterogeneous, related not to the present stream but to others flowing in very different climatic environments or is due perhaps to non-fluvial agents. The relative erodibility of the deposits in which the river flows, using the term in a manner heavily criticised by Yatsu (1966), will exercise local control over the form of the long profile, leading to convex upward sections as the river is superimposed onto resistant rock outcrops.

Leopold, Wolman and Miller (1964) noted that the vast majority of river long profiles are concave upwards but also say "although much of the discussion of the longitudinal profiles of channels seems to assume that they are smooth curves or composites of smooth curves, this is rarely so. In addition to bars, pools and riffles, variations in discharge and in lithologic and structural controls often produce irregularities of a larger scale" (p.258). This is well illustrated by the work of Yatsu (1955). Thus, in a recently glaciated area, the variations in discharge of tributary streams due to differences in size or rates of melting of glaciers and the variation in position of an ice front from which proglacial deposition commenced, associated with the occasional superimposition of the rivers onto more resistant lithologies suggests that, even without base level change, it is improbable that stream long profiles in the course of intermittent downcutting were always parallel with their predecessor. It is unrealistic, therefore, to expect the terrace sequence in such an area to consist even largely of smooth parallel or simply intersecting ellipsoidal fragments, except where marine influence is dominant.

The most frequent explanation of irregularities in a smooth river long profile is that these are nickpoints (The American Geological Institute Glossary (1957), quoted by Brush and Wolman (1960), defined these as 'points of interruption of a stream profile at the head of second cycle valleys according to the Treppen concept' while knickpoints are defined as: 'points of abrupt change in the longitudinal profile of stream valleys'). Much evidence exists, as in Rose (1964), that some of these knickpoints are unstable features and that they eventually disappear through head-ward retreat or flattening, and may have terraces associated with them. Such field evidence is confirmed by laboratory studies, including that of Lewis (1944) and Brush and Wolman (1960). Yet it is equally true as Dury (1966) stated, in using the American genetically defined 'nickpoint' as a non-genetic term, that these features can develop in mid-profile, independently of shifts of controlling base level. Peel (1966) and others have shown that they do not necessarily coincide with obvious lithological variations.

The concept of grade, of a static equilibrum system which, when disturbed, readjusts through the creation and eventual disappearance of nickpoints, has suffered many critical attacks, the most recent of which is by Dury (1966). In concluding his highly critical essay he said: "because the concept of grade necessarily involves the converse idea of an ungraded state, it is to be recognised as unserviceable in the theoretical analysis of landforms generally" (p.231). As Woodford (1951 p.819) pointed out in the case of the Middle Rhine, which has at one point a humped profile over a buried buttress of bedrock "no available evidence indicates that the equilibrium of the unregulated Rhine was less perfect here than in other parts of the Rhine graben".

It is now generally accepted that viewing a river as an open rather than a closed system (Chorley 1962) is more valid. Thus the term 'dynamic equilibrium' has become popularly used to describe river systems in a steady state, into which there is a continuous inflow of materials. Perhaps the most important difference between the two types is that the open system can regulate to changes in discharge and load in many more ways than the closed system; the creation of nickpoints at a river mouth is not essential in response to changes in load or base level. The attraction of lack of indeterminacy in the closed system as Cotton (1941) enunciated it, which led him to state "all river terraces are definitely features of river youth" is no longer acceptable as it has proved to be a 'noisy model'. Just as alternative or multiple causes may be possible for isolated terrace remnants, the same can be true of whole terraces.

D(iii) Fluvial terrace long profiles and landscape evolution in the Literature

Virtually every possible combination of terrace long profile form has been reported in the literature. A diagrammatic summary of these and representative papers in which they are noted or discussed is given in figure 2.3.

Relict fluvial terraces owe their elevation above or depression below the present stream to three fundamental controls which are tectonic displacement, climatic change and the influence of man. The last control effectively creates either tectonic or climatic change in the building of dams and weirs or the burning of vegetation and creation of field drains. Elaboration of the first two controls is given in Leopold, Wolman and Miller (1964 p.475). Generally, however, much less general answers to the problem of terrace origin are required than can be given by this tripartite division.

<u>Long profile forms</u> The most common general explanation of layout A in figure 2.3 has invoked tectonic activity, leading to a progressive rise in the headwaters region or alternatively pulsed downcutting in the area under consideration and rise of base level outside that area. A more likely explanation in recently glaciated areas like the Tweed Valley, as suggested by Sissons (1967a p.117), is that this is comprised of both ice-proximal outwash and post-glacial river terraces.

Layout B is much less common in the literature but is a summary of the results obtained by Kirby (1966). While possibly due to upwarping of the downstream section in some areas of the world, the explanation in the case of the Esk Basin (Midlothian) terrace sequence is more likely to be found in changes of hydrological parameters and changes in direction of drainage, leading to misleading projections onto planes suitable for later stage features. Thus in this case it may be more apparent than real.

The third layout, C in figure 2.3, appears frequently in the works of Zeuner and others working on Western European terraces, although it has often been based at least in part on inadequate altimetric evidence (e.g. Kimbal and Zeuner 1945, Siegert and Weissermel 1911, quoted in Zeuner, 1959 p.84). Zeuner (1959 p.45) explains that under periglacial conditions, considerable solifluction and frost weathering takes place, leading to an excessive load being supplied to diminished rivers. These rivers, usually related to a lower base level as world sea level fell in the glacial periods with the abstraction of water to form ice, rapidly aggraded in the upper regions. In succeeding Inter- or Post-Glacial times, the same rivers, flowing through areas with a complete vegetation cover, were supplied with a much smaller load and were also related to a higher sea level. Thus downcutting in the previously aggraded area occurred while burial of the lower terraces proceeded simultaneously.

A number of qualifications need to be made about this long-accepted and attractively simple scheme. The first of these is that the ready acceptance of all knickpoints as nickpoints, for example in the interpretation of the 'longitudinal profile of the benches of the River Thames' (Zeuner 1959 facing p.358), itself largely based on questionable borehole evidence, must be regarded with suspicion in view of the recent work outlined in the previous section. Furthermore, the supply and type of debris delivered to the river probably varied considerably on a regional, local and temporal basis. Zagwijn (1963 p.184) critised what he described as "the erroneous belief that Glacials are characterised by coarse clastic sediments, presumably laid down by braided rivers, whereas Inter-Glacials are marked by sedimentation of fine sand and clay in meandering river systems". In the Netherlands this situation, although present, is far from ubiquitous. Only now are local sea levels at various stages in the last 20,000 years being accurately worked out (Sissons 1966, Jelgersma 1966) and thus a check provided on the accuracy of at least some of Zeumer's correlations of terraces and sea levels.

The easiest and therefore most widely used terrace sequence for deducing past sea levels is D in figure 2.3. Such a sequence is conventionally taken to be due entirely to eustatic effects and numerous estimations (e.g. by Wills 1938) of contemporaneous sea level have been made where terrace gradients were believed or shown to be small. The growth of curve fitting to terrace long profiles, a technique first used by Tylor (1875) and popularised by Jones (1924) and Green (1936), in order to ascertain previous sea levels quantitatively, is now recognised to be fraught with hazards (Austin Miller 1939, Kidson 1962, Peel 1967). Although at first sight particularly suitable for eustatic terraces, many possible curves can be fitted to any set of data which, when projected, give considerable variations in the height at which the curve is asymtotic to a line parallel to the X axis. Furthermore, the method relies on the assumption that the river was in a 'graded state' at the time of formation of the terraces. Use of the technique should be limited to those cases where paired terraces can be shown to exist.

The terrace layout E, often shown as the upstream segment of D, is also one in which curve fitting has frequently been employed to ascertain past sea levels. In many ways this is the most popular preconception of what terrace sequences are like in upland areas of Britain, to judge by the frequency of its occurrence in the literature. It is interpreted as showing terraces related to higher sea levels and becoming relict features by the headward movement of several nickpoints. Apart from an often regrettable lack of accuracy in the basic data, such conclusions rest upon the usually unjustified assumption that the knickpoints in the profile are also nickpoints. The layout F in figure 2.3 has been suggested by Frye and Leonard (1954) as a viable alternative to E where field work has not been careful enough to prove the issue one way or another.

That such detailed work as that of Smith (1965) who, in attempting to correlate terraces and raised beaches in Fife, had little success, emphasises the care that must be taken in formulating conclusions on past sea levels based on fluvioglacial terraces. Thus the results of de Lamothe (1918), Deperet (1918), Wills (1938) and Zeuner (1959) among others, in so far as they are based on terrace long profiles must be viewed with reserve. In many such cases there is no indication of the location of the shoreline, a further factor leading to likely inaccuracies.

Originally inclined surfaces are much more difficult to use as indicators of tectonic displacements than those which were originally near-horizontal, such as raised beaches. Despite this, terraces have been used in parts of the world as indicators of local warping or faulting. Papers by Putnam (1942), Coleman (1958) and Juen (1966) provide examples where earth movements are claimed to be shown by the terrace sequence and several recent Japanese studies have thus used terraces. The situations are illustrated diagramatically in G and H in figure 2.3.

It is manifest that far reaching conclusions have been derived from terrace sequences built up on correlationof supposed synchronous fragments. In the light of correlation difficulties and others of ensuring the selection of representative values for the parameter investigated (Chapter 3), most conclusions on landscape evolution resting solely upon altimetric data can only be accepted with caution.

CHAPTER 3

FIELD SURVEY TECHNIQUES AND ASSOCIATED PROBLEMS

A. Mapping the Terrace Fragments.

Initial mapping of the terrace fragments and associated landforms was attempted on vertical aerial photographs at a scale of 1/10,000. Even when using a stereoscope, considerable difficulties were encountered in distinguishing between scarps of low level, low altitude terraces and channels on the floodplains. The method was therefore abandoned in favour of field mapping of terraces and associated fluvio-glacial features although it proved useful in a reconnaisance role. Transfer of these features to maps was carried out using a 'Sketchmaster' and was particularly easy due to the high degree of control afforded by the numerous field boundaries and other man-made elements of the land-scape.

Field mapping to delineate the extent and, where possible, the nature of the terrace fragments and all associated landforms was carried out by systematically walking over sections of one kilometre squares adjacent to the river, presenting the results on a scale of 1/10,560 and recording exposures (and information provided by inhabitants) in field notebooks. Fragment numbering commenced at the river source, left bank fragments being assigned even and right bank the odd numbers, all being prefixed by the letter F. The symbols used in mapping were simple developments of those used by Hare (1947) and Sissons (1958) for terraces and fluvioglacial features respectively. While the 100 mile (160 kilometres) length of the river Tweed was covered in this way, the width of the area mapped varied between 2 and 7 kilometres according to valley form. An Abney level was found to be useful in providing a first approximation of the nature of the down and cross valley profiles of the terrace fragments.

It was apparent from the outset that mapping on the six inch scale was essential if all the features were to be accurately represented in position and extent. Field mapping on the 1/25,000 scale, as utilised by Coleman (1958) Powers (1962), Straw (1966) and many others is suitable only where 'representational' rather than 'true scale' mapping is involved (in reconnaisance work) or where the terrace surfaces can be seen in the field to be continuous for several miles and separated by a considerable vertical amplitude.

The use of a scale larger than 1/10,560 was deemed unnecessary for the purpose of this study: terraces have been mapped on larger scales by some workers (e.g. Machida (1960) mapped on 1/3,000 scale) but usually at points selected because of their special interest, not continuously from source to termination of the river. Flats smaller than about 30 yards long rarely have any great significance because post-depositional erosion has greatly influenced their present form: as one tenth of an inch on the 1/10,560 scale represents a distance on the ground of eighty eight feet, it is clear that for the accurate representation of significant terrace surfaces, this scale is quite adequate.

B. Heighting the Terrace Fragments.

In attempting to correlate synchronous terrace fragments or deduce their origin, both absolute height and gradient in two directions of the terrace are minimal requirements. Having thus defined the surface geometry, certain tests of significance of these values must be made before they can be used in any analysis. Such tests include examination of the errors obtained in mapping and measurement, along with a consideration of the degree of surface dissection, relations to higher and lower terraces and relationship between stratigraphy and morphology, where sufficient data are available. A substantial percent-age of the voluminous literature on terraces does not consider such fundamental principles. As typical examples one may cite Coleman (1958), who did not state at what points on the Salzach terraces her heights were obtained, while Clayton (1953a) omitted not only the location of the heights but also the means of obtaining them.

The widespread applicability of conclusions on suitable techniques of heighting terraces will be limited by varying local conditions: if terraces are separated by vertical intervals of perhaps three hundred feet, less sophisticated survey techniques can be employed than in an area like the Tweed Valley where crossing terraces occur and few fragments are more than one hundred feet above the river. Accepting this, it is still possible to usefully consider the problems associated with heighting terraces under four broad headings:

(i) Location of the heights on the terrace surface

An important principle of any measurement of the shape or size of several like objects is that the values should be comparable in being selected from identical locations on each object, in this case on terrace fragments.

Heighting on anything but a grid or in a genuinely random manner implies some belief in the special significance of the points chosen and also that these locations can be identified on all fragments of terraces. Unhappily, there is as yet no agreement on significant and easily locatable locations on terrace surfaces such as is found in the literature on raised marine flats (e.g. Austin Miller 1939, Sissons 1967c) but there have been several suggested solutions. Thus, Davis (1909) put forward the hypothesis that the only significant height on any terrace surface was along the junction of the backing scarp and the flat itself. Others (e.g. Sealy and Sealy 1956, Thomas 1961) have implicitly concurred in this but cautiously heighted both the back and the front of terrace fragments.

Frequently, however, in the Tweed Valley at least, the back of the flat, be it flood plain or relict feature, is marked by the line of a channel, utilised on the lower terraces in time of flood. There is little point in heighting along an irregularly infilled channel when the adjacent terrace surface is usually much less irregular. Older terraces, particularly those formed in other ice-marginal areas and times, are frequently reported to have slopwash or solifluction deposits obscuring the break of slope at the back of the flat. While this is rarely a problem in the thesis area, it provides a further general limitation to this means of characterising the terrace. In any case, there is no firm evidence that this break of slope is always a genetically significant feature.

These difficulties associated with heighting of the rear of any terrace remove from consideration the only readily recognisable 'line of significance' . Perhaps this is fortuitous as there are several theoretical possibilities that could never be picked out employing solely a single line of heights e.g. slow continuous downcutting of a stream in which the meanders were slowly shifting downstream but not laterally, would cause this line along the back of the terrace to be diachronous; the apparent gradient of such a terrace could well appear to be indicative of ice-proximal glacial outwash rather than of a moderate slope uni-channel stream.

The front of a terrace, unless it is the floodplain, owes its form and location almost entirely to post-depositional erosion. Heighting along the rim can only be accepted as representative of the downvalley gradient (and therefore be strictly comparable with other terraces) if the cross valley gradient is zero and a suitable projection line is employed. If, as in the case of the Tweed Valley, many terraces are higher at the front than the back (see fig. 3.1) or if the opposite is true (e.g. Machida 1960) then grave dangers exist of obtaining a component of the true downvalley gradient. In cases such as that detailed by Mackin (1937) where slopewash now covers the original terrace, resulting in a gradual cross valley descent towards the river, the only spot at which the original form can be heighted is at the eroded frontal scarp. Thus the buried surface must be assumed horizontal in cross-profile, except where it is possible to show otherwise in stream-cut sections.

A variation introduced by Hare (1947) was the heighting of surfaces by making cross-profiles of the terrace at quarter mile intervals, then plotting maximal and minimal values onto a projection plane. A smooth curve was then plotted through the series of twin heights to represent the terrace gradient. While the method is simple in practice where surface gradients are small, the smoothed mean is frequently likely to be lower than the correct value owing to secondary erosion of the flat. A more reliable method might be to plot the medial value of each cross-profile of heights.

A considerable improvement in accuracy, sophistication and usefulness of results can be afforded by occasionally traversing at right angles to the main downstream or down valley traverse line (e.g. Kirby 1966). With such data it is possible to calculate the true maximal dip vector of all the surfaces, which will trend downstream, towards or away from the river depending on the cross valley gradient and thus anomalous features will be isolated. As little variation in cross valley gradient takes place, traversing in two directions at right angles approximately fixes the terrace in three dimensions.

The flood plain features in the Tweed valley were heighted in this manner by traversing along the rim and across the widest stretches. This was done initially to ascertain if the expected close relationship between river level and floodplain rim level emerged. Some of these supposed present-day features were also heighted down their centre and down the rear break of slope, to compare the various results. In the case of older terraces which were relatively narrow, little choice in the orientation of lines of heights was available; a line down their length plus short cross traverses where broad enough to justify this were used to locate the flat in three dimensional space. In the few instances where extensive old terraces do occur a variety of height layouts was employed: using suitable projection planes, either downstream or downvalley gradients could be obtained. The ratio of downstream to downvalley gradient is a function of the sinuosity of the stream which laid down the sediments whose surface expression is the terrace fragment; unless it is assumed that the streams responsible for relict terrace and present day floodplain had the same sinuosity index (see fig. 3.2) it is not possible to compare directly terrace gradients on a downstream basis. In addition, the problems associated with the formation by braided streams of at least some of the older features are sufficient to completely negate the possibility of downstream comparisons (see Chapter 2).

The variety of height layouts used in this study is justifiable as:

a). Levees (and other primary features) and thus cross valley gradients, are small: in no case did the maximal cross valley difference in relief on a terrace, except where very obviously due to post-formational erosion, exceed 5 feet in this area. This naturally precludes the possibility of separating terraces of a similar gradient but different age within the maximal original local height difference on any simple non-areal comparison but, as in most cases the relief variations are smaller than 5 feet, the height layout pattern is not, so far as this factor is concerned, of great significance.

The range of relief on floodplains is variable: Fisk (1944, 1947) reported levees of up to 15 feet high adjacent to some sections of the Mississippi and St. Clair (1937) contended that these may exceed 25 feet in certain circumstances. Fenneman (1906), Wolman and Leopold (1957) and many others have drawn attention to streams entirely lacking levees, often having little relief. Hjulstrom (1952) quoted cross valley variations in height on what he believed to be present-day Icelandic sandurs of up to 3 metres in a kilometre wide valley and this was confirmed by Krigstrom (1962)

b) The distortions due to heighting in different locations are, in this study, small compared with those engendered by the projection effects (see Chapter 8)

c) A test program involving the fitting of trend surfaces to a terrace fragment (F 585) heighted in the normal way i.e. round the rim usually the highest part plus cross profiles, compared favourably with one fitted to gridded heights on the same feature. This shows that it is possible in some instances at least to derive heights of the accuracy required for any point on a flat, from simple but accurate traverses (see Chapter 11)

<u>(ii) The theoretical variations in possible frequency and density of non-co-linear height coverage of terraces.</u>

Only three heights, together with their respective X and Y Cartesian coordinates, are required to establish the position of any laminar surface in space. Terrace fragments are in many cases close approximations to such laminar surfaces but generally require rather more numerous surface coordinates for reasonable definition. The following factors govern the theoretical frequency and density of point coverage required (the difference between frequency and density is illustrated by figures 3.3 A, B and C which show equal density but widely varying frequency of surface heights):

a). Vertical interval between terraces. Other factors being constant, the greater the vertical distance apart of the terraces, the fewer the heights that will be needed to distinguish between any two.

b). Gradient of terraces. It is frequently more important to ascertain whether a surface is horizontal or, say, sloping at 5 feet per mile than it is to quantitatively distinguish between two surfaces sloping at perhaps 74 and 79 feet per mile. Therefore a greater density of surface heights will generally be required when surface gradients are low rather than high. Likewise, in the case of crossing terraces, the greater the difference in surface gradients, the fewer the measurements needed to separate them.

c). State of surface dissection. Where terraces are continuous for several miles and largely unscarred by scour routes and other surface channels, few heights are needed on the surface if it is known not to be a composite feature. If however, the variations in stratigraphy common in crossing terraces are not exposed, then a higher density of surface heights will be required, other things being equal, to distinguish the differing gradients than would be suspected from casual examination.

d). Original terrace morphology. An undisturbed horizontal cross valley profile of a terrace can be exactly represented by one point, rather than the two or more required for originally inclined or complex surfaces. In the case of the older terraces, post-depositional erosion has greatly altered the original form such that with increasing dissect-ion, increasing height density is usually required (see sub-section C above). In other cases, however, particularly where relatively recent relict features are concerned, post- depositional modifications have resulted in obliteration of the original swales and bars, leading to a smoother and thus more easily defined if less significant surface.

e). Type of terrace. Certain terrace types are unlikely ever to have been continuous for more than a few hundred yards even when originally formed. Such terraces include high level kame terraces and terraces resulting from dissection or slumping of some types of subglacial sediment-ation including ice tunnel deposits formed against a moderate to steep slope. Where field evidence suggests this is the case and the terrace is worth heighting,the height frequency then depends upon:

f). Purpose of heighting. In theory, where the origin of the feature is already known e.g. where outwash is clearly related to moraines, and it is necessary to establish a chronology and cross valley correlation, there is every justification for continuous down-terrace heighting. Where only the origin of the surface is required, grouped or clustered height layouts could be used, perhaps at down valley intervals of a mile or more, depending on the continuity and size of the terraces. Such an individual layout would have to cover an area greater than the threshold over which the regional terrace trends become more important than local surface variations in altitude.

g). <u>Amount of time available in relation to the methods employed.</u> Given that a certain finite time is available for surveying a specified number of features, the number and distribution of heights possible will be limited by the survey method employed. The distance the height will have to be 'carried' from the nearest datum point will also limit the amount and layout of data pertaining to the terrace itself.

<u>(iii) The height layout patterns employed.</u>

The combination of all the above factors dictated the use of distributions 1) and 2) from the number of possibilities illustrated in figure 3.4. Various combinations of these layouts are possible e.g. stratified random sampling. While it was intended to use 1) throughout, it soon became clear that the varying interval linear distribution 2) was occurring owing to variations in surface texture, firmness and relief over which the heights were collected (see section on levelling). This has the theoretically important advantage that any cyclic variation in terrace height of a wavelength similar to the interval between two consecutive heights which are part of distribution 1), or a multiple of that distance, cannot slip through the 'height mesh' - the same argument would suggest that either randomly distributed or clustered data would be more suitable height layouts than the grid form but at least the former is much more difficult to set out (Greig-Smith 1964 p.24).

The interval between consecutive heights was made 60 to 70 paces on long terrace fragments and 50 on short or greatly dissected flats. It was felt that this was a reasonable compromise bearing in mind all the variables listed. The method of heighting employed (see next section on methods) was such that heighting at 50 pace intervals took little longer than heighting at intervals of up to 2 or 300 yards. On the other hand, the increase in accuracy of representation of the terrace slope and altitude will tend to fall off markedly after a certain height frequency or total number of heights is attained on any one flat. Thus there is no point in heighting either closer than this critical distance or obtaining more than the critical number of heights. While in the individual case these will probably be functions of the nature of the surface, experiments were conducted to obtain mean values for them when distribution 1) was employed. The results of these tests are discussed in Chapter 9, the raw data being set out in appendix 2. In general, however, there is every reason to believe that the heighting interval employed is a suitable one.

The Grouped layout of data (distribution 3) in figure 3.4) has attractions in offering ease and quickness of layout yet permits quite sophisticated analysis e.g. derivation of the gradient vectors for each ring, for all ring centre points and also ring combinations. It was not employed as, although suitable for characterising single surfaces, it would not identify the junction of two crossing terraces precisely enough unless carried out at intervals of perhaps 200 yards or less. Thus the considerable advantage of quickness of layout would be lost.

Concern has long been felt on the effects data distribution can have on conclusions. Equally, the proliferation of statistical techniques in certain fields, such as the fitting of trend surfaces by Fourier Series rather than by the more usual orthogonal polynomials (e.g. James 1966) can be seen as a response to the inherent filter effect of any one data analysis system in its use when studying any one set of data. It was not found possible to develop a Fourier

Series-based trend surface program in the available time to test the effects of the data analysis system but, as already noted, the effects of different data distributions on terrace fragments were tested by quantitatively comparing trend surfaces fitted to random, clustered and gridded height layouts. The details of the techniques employed are set out in Chapter 11 while the raw data are tabulated in appendix 1(b); figure 3.5 illustrates the different point distributions employed.

While the details of the techniques are irrelevant here, it is appropriate to consider the height layouts. In those cases where gridded data were obtained from terrace surfaces, considerable care was expended in ensuring that a constant grid size of 50 yards was obtained and also that the grids on remnants on both sides of the river 'meshed' together exactly to avoid any possible complications in the statistical comparisons. The grids were set out by the 'straight line and offsets' method, the orientation of the original base line being chosen to maximise the areal cover possible on the largest terrace fragment and thus avoid recourse, where possible, to setting up parallel secondary base lines.

Chorley and Haggett (1965) suggested that a triangular grid network offered the advantage of complete freedom from contour plotting ambiguities. Such a layout is slightly more difficult to set out in the field but, if the indeterminacy problem should prove to be significant, techniques exist to convert rectangular grid height distributions into the triangular or other forms. These are discussed in Nordbeck (1964), Ojakangas and Basham (1964) while Cole, Jordan and Merriam (1967) were necessarily involved with the related problems of automated contour interpolation.

The coordinates for the random distribution of heights were chosen by adding to 69 and 33[1] pairs of random digits chosen in the manner suggested from Anon (1955) to give eastings and northings correct to 10 metres on the ground. All of those which fell outside the terrace limits as mapped were excluded and the process continued until 90 terrace surface locations were generated in this 1 kilometre square centred on 6950 3350. The data for the clustered distribution were obtained by adding some gridded heights to those collected along the rim on the fixed interval linear height layout system.

iv) Methods of heighting

Suitable surveying methods will vary with local circumstance and the accuracy required; in the complex situations that may occur in recently glacierised areas it is always best to err on the side of unnecessarily great rather than insufficient accuracy. Whatever the method used, it should be capable of consistent and checkable results: it is of little value having an instrument which will give results correct to $\pm$ 2 feet on 70 percent of the occasions used if the other 30 percent of the time errors are as large as, say, $\pm$ 8 feet.

a) Estimating heights. The simplest of all methods of obtaining heights for specified locations is by estimation with reference to some nearby datum level, frequently of indifferent accuracy. Thus Wills (1924), Tomlinson (1925), Rice (1957) and many others have estimated terrace heights from nearby contours (most of which are interpolated) and spot levels.

1: the National Grid easting and northing of the southwest corner of the 1 kilometre square in which lies the section of F 585 covered with different data distributions.

The likely errors involved in the method are difficult to quantify due, as they are, entirely to individual judgement and local circumstance, but it seems reasonable that anything up to $\pm$ 10 feet might be expected where height control is good and up to $\pm$ 25 feet (or perhaps more) where datum level is far removed from the terrace or is itself inaccurate. What is even more important in such circumstances is that although the 'absolute' height at any one point may be estimated correctly, the chances of repeating this accuracy initially diminish with increasing number of heights taken on the same terrace. Thus in some cases there will be a decrease in accuracy of gradient representation with increasing number of spot heights until a certain threshold is reached where the number of heights on any one surface rises above a critical figure. It is extremely difficult in making subjective assessments of this kind to avoid being influenced by previous judgements: thus it is quite likely that if the first height is wrongly estimated, all the rest will be in error. Clearly therefore, either gradient or height of terraces or both are likely to be considerably and ubiquitously in error with this technique and it should be avoided whenever possible.

b) Measurement by use of the hand level. Next to estimation, the simplest method of heighting involves hand instruments such as the Abney level, usually used without a levelling staff (e.g. Bryan and Ray 1940, Hare 1947). The method used by Synge and Stephens (1966) is typical of the manner in which the instrument is frequently employed. Keeping the sights horizontal, any object on the same horizontal plane as the observer's eye is located on the slope leading up to the raised beach or terrace flat. The observer then moves to the object and repeats the operation until reaching the top of the slope; the height of the terrace rim is then a multiple of the observer's eye height plus a fraction of the same above the datum level.

If the quoted maximal errors of 8 inches in 130 feet of vertical traversing (Synge and Stephens 1966 p.105) could be accepted, there would be little point in using any other method but serious doubts must be attached to this technique for the accurate definition of heights. In the first place, the answers are not checkable by 'closing' any traverse except by continuing to a higher datum level. It is virtually impossible to traverse downhill with this particular method and thus the only check is by repeated uphill traverses, while it is impossible to survey any feature from a higher datum level. Even repeated 'one way' checks are not satisfactory as in the most objective observer a subliminal element must be expected which will tend to alter the exact location of the cross wires to provide the same answer as on the preceding traverse. Usual errors are much greater than quoted and may amount on occasions to as much as $\pm$ 15 feet in one hundred feet vertically. Even greater errors are possible where the instrument is used to take inclined readings.

As with estimated heights, the terrace gradient may be very considerably in error if deduced from only a few heights, some of which are too great and the others too small. A difference of two feet at one end of a small terrace fragment may double or even reverse the gradient, depending on the figures. While it is possible to use this instrument to an acceptible degree of accuracy when in conjunction with a levelling staff, the advantages of single-man working and rapidity of traversing are lost, without gaining the greater degree of reliability inherent in traverses carried out with an accurate level.

c) Measurement by use of the aneroid barometer or altimeter. Heighting terraces by aneroid barometer or altimeter has strong advocates: Sparks, for example (Sparks 1953, Hamilton, Biddle and Sparks 1957), considers that there is no point in measuring to one foot accuracy or less. Thus, he says, the aneriod is the ideal instrument provided suitable precautions are taken: this statement is based on confusion of instrument sensitivity and accuracy. The likely error is quoted as within ± 5 feet of the correct value - a figure which immediately invalidates use of the instrument so far as terrace gradient measurements are concerned unless very large numbers of heights are taken.

Much of the early work on terraces carried out with aneroids clearly suffered from the defects of instruments of the period. The pioneer Milne Home listed, in his 1875 paper on the River Tweed and its environs, numerous terraces in terms of height above the river and also above mean sea level. Most of these heights were obtained using an aneroid but on some occasions this was checked by levelling. Subtraction of the two heights he gave for each terrace provided the raw data for figure 3.6, a graph of river surface altitude against distance. Neglecting the heighting of the water surface (and terraces in relation to it) in the tidal area which extends 5 miles upstream from the river mouth, the aneroid results show errors ranging from zero to 16 feet and generally do not compare well with the levelled profile.

A recent instance of the unsuitability of the aneroid barometer for the separation of terrace features commonly found in Northern Britain is given by Sissons (1967a). He compared heights of two raised shorelines obtained from altimeter traverses with accurate levelled heights (p.167): on the basis of the barometric work it was impossible to separate the two flats but both were quite distinct on the levelled profiles, some 9 feet apart. It should be noted, however, that where as 34 levelled heights are illustrated, only 12 obtained with the altimeter are shown - thus the results are in part due to different data densities.

To test this latter point and evaluate the suitability of the altimeter for heighting terraces in recently glacierised areas, a comparison of levelled and barometric heights taken at similar intervals was made on several terraces in the Springhall district of Berwickshire, as illustrated in figure 3.7. In the case of the long terrace fragments, numbers 630 and 632, the statistical treatment of the results (which assumes a linear long profile for the terraces over a short distance) showed that substantial differences in 'absolute' height as obtained by aneroid and by accurate levelling occurred. In the case of the results pertaining to F 632, a statistically significant difference in terrace gradient was obtained by the use of the two methods. (The raw data is set out in appendix 1(d) while the regression lines and correlation coefficients were calculated as described in Chapter 9). The two small fragments, F626 and 634 are inseparable on the basis of barometric readings and considerable variations exist in the values obtained. Every care was taken to ensure that the conditions stipulated by Sparks (1953) were observed: all traverses were shorter than one hour in duration and were closed on the original datum, an Ordnance Survey bench mark known to be reliable from other work. The difference between the original and final readings at the bench mark was distributed throughtout traverse on a time basis. The instrument used was a Paulin altimeter, model 'Palbo'. The air temperature throughout remained at about 9 degrees Centigrade while the wind speed did not exceed 5 m.p.h. (8 k.p.h.) and a complete cover of stratus cloud existed. Other relevant details are recorded on the graph.

Dissatisfaction with the aneroid was also expressed by R.J. Price (pers. comm.). In studying the glacial deposits associated with the meltwater systems in the upper Tweed Valley (Price 1961), he heighted all the terrace flats, taking care to observe all the essential safe-guards for accurate working. Despite this, the results were quite unintelligible in an area varying considerably in its degree of complex -ity of recent geomorphic evolution.

Disenchantment with the results obtained by French workers using aneroid barometers to height terraces led Bourdier (1959 p. 24) to comment: "...comme le disait plaisamment Maurice Gignoux, il suffisait d'avoir un altimetre fixe au guidon de sa bicyclette pour devenir un specialiste dans un des domaines les plus difficiles de la geologie."

An important restriction to the use of the aneroid is provided by the weather. Sparks (1953) suggested limiting altimetric surveying to times when:

1) stable anticyclonic conditions prevail, or

2) when a large continuous rise or fall of presure, not associated with the passage of a front, is occurring.

Such conditions are relatively rare in Northern Britain especially when the maximal wind speed should not exceed 12 m.p.h. while traversing is carried out.

Numerous other restrictions to surveying exist. If not observed, the effects combine with datum and observational errors and instrumental factors to insure that, although the modern aneroid may have a sensitivity equivalent to a one foot change in elevation, the accuracy in the field is variable and usually considerably short of this figure. A full treatment of surveying techniques and possible errors is given in various publications e.g. O'Connor (1957 and 1958), Hamilton, Biddle and Sparks (1957) and Crone (1961).

Thus it seems reasonable to conclude that only in suitable weather conditions and when studying terraces which are (Johnson 1944 p. 799) clearly developed, only a few features existing, and separated by scores or hundreds of feet is the aneroid a suitable surveying instrument. As Johnson also stated, it is essential that the traverse takes little time and that checking by stationary instrument at a control point is possible. In complex areas, sufficiently accurate answers are sometimes available but not with sufficient frequency to justify its use. The most that can be said in favour of the aneroid barometer is that its use in terrace studies need involve only one person and that it is more rapid than using an accurate level over the same number of points. The requirement of a higher density of heighting than with the optical alternatives greatly reduces the second advantage.

d) <u>Measurement by photogrammetric methods</u>. Photogrammetric techniques for heighting have considerable advantages over field survey, providing certain conditions are met. The first requirement is good quality vertical photography, allied with the services of a skilled photogrammetrist. Heighting gently inclined surfaces such as terraces, many of which slope at only one or two feet per mile in the lower reaches of river valleys, provides accuracy problems only soluble on a second order plotter even assuming the photographs and worker are of the desired standard.

The advantages of the technique lie in the diminution of field work necessary, although total time required may indeed be increased. Once a good height control network is set up, vast amounts of data can be extracted on any height layout system required.

The non-existence of suitable aerial photographs and manipulative skills combined with the lack of a high enough order plotter in the locality precluded heighting on this basis in the Tweed Valley. It is clear, however, that at least in other more remote areas suffering markedly from vagaries of climate, the use of photogrammetry would be extremely sensible.

e) Measurment using surveyor's level and staff. It has already been pointed out that in the Tweed valley as a whole it is impossible to separate terraces of similar gradient that are closer than five feet apart vertically, using simple non-areal analysis. The justifications for widespread use of a technique more accurate than this are threefold:

1) This limit to simple correlation can only be established by accurate measurement of maximal difference between heights at the fronts and backs of terraces and those between the altitudinal extremities of primary ridges and depressions making up the terrace.

2) Gradient measurements are important and frequently involve much smaller figures than five feet.

3) It is important to know accurately if two terraces are separated by more or less than five feet and thus if they can or can not be distinguished as representing different stages.

Apart from the work of Peel (1941), Kirby (1966) and occasional use by others, usually as a check on results derived from less accurate techniques (e.g. Milne Home 1875) or in accurately locating bores for stratigraphic purposes (e.g. Shotton 1953), the accurate level seems to have been a neglected tool in terrace studies, in the English-speaking world at least. This is despite its suggested use by, among others, Stevenson (1896). A terrace, apparently horizontal in long profile, in the Whiteadder valley caused him to remark on the necessity of using a level to ascertain if this was, as it appeared, to be lacustrine in origin.

Until recently this has possibly been due in part to the apparently monotonous and laborious nature of the work; as Peel (1966) has commented, such fieldwork is far from monotonous and the advent of the automatic level, in which fine adjustment in the vertical plane is continuously effected by a pair of pivoted prisms or a similar device, has done much to reduce the time needed for any traverse involving many intermediate sights. Levelling permits a check on the total error in a traverse of forward and backward sights by 'closing' on the origin -al or a second reliable datum level.

Use of the level and errors associated with it are adequately covered in the standard texts: to those possible errors given in Anon (1965 p.159) viz. those connected with the instrument, those due to the staves, those due to atmospheric refraction and those due to an alteration in the height of the supports for the staves between the forward and back readings to a staff, must be added misalignment of the prisms due to shock suffered by the automatic level. This was guarded against by repeated checking (on most field days) by the standard test, carrying out adjustment when necessary.

The considerable advantages of this type of instrument resulted in its use for a large proportion of this study. Although in most cases needlessly accurate (Anon 1965 p.154 gives a figure of 0.01 feet per mile probable error for tertiary levelling) the use of unskilled assistants as staff holders and traversing over fields, often ploughed, increased this figure so that the maximal closing error was approximately 0.5 feet, while the usual error varied betweem 0.1

and 0.2 feet. Errors were distributed throughout traverses on the basis of the number of instrument stations and the heights then rounded off to the nearest one place of decimals e.g. 100.4 feet. In this way, between 60 and 100 levels per day on terraces were accomplished at the frequency stated earlier. It was found possible to gather[177] heights on a rectangular grid form over terrace fragment number 585 in one long field-day. All of this work was carried out in a variety of weathers, only extremes of snow, rain or wind rendering heighting impossible, in marked contrast to the susceptibility of the aneroid to such adverse conditions. Two instruments were used, the Hilger and Watts Autoset marks I and II.

The problem of locating the spot levels to within the plotting error on the 'six inch' map was simplified by the large amount of control available in the Tweed valley in the form of walls, fences, houses, streams, roads, copses, etc. Whenever these were passed appropriate notes were made in the levelling notebooks. Reproducibility tests showed that the same locations could be picked up by an independent observer familiar with ten metre grid references: all heights were identified in this way (see appendix I). In areas without such overall locational control, it would be necessary to take readings of angles between adjacent sights and distance to each staff position, calculated from use of the stadia intercept and thus involving more office and field work.

f) Use of tacheometric methods. The level is ideal for cases where locational control is good and variations in height are small, a frequent situation on terrace fragments. Where the datum level is far removed from the terrace in a vertical sense, the use of tacheometry for heighting has obvious attractions.

Certain parts of the Tweed Valley fulfill these conditions and a Kern DKM 1 theodolite was used to height 6 terrace fragments employing the vertical staff system e.g. for F 364. This involved measuring vertical angles and 3 stadia intercepts, in place of the single intercept used in simple levelling. Further time-consuming factors involved are the constant readjustment of the 'horizontality' of the instrument (i.e. it is not automatic) and the many more tedious calculations that have to be made to arrive at the height values. Positioning in plan was carried out by the same means as when levelling. The expectable errors associated with the method can be expressed as 0.01 L for single rays, where L is the length of the ray in feet and vertical angles less than 15 degrees are observed. A short description of the techniques and errors involved is given in Anon. (1965 pp. 187 - 92). In no case did the closing error of the few short traverses carried out exceed 0.5 feet and most were of the order of 0.2 feet. Appropriate redistribution of the closing errors was carried out.

g) Future trends in terrace heighting. Experience gained at a late stage in the field work with tacheometry suggests that a good case exists for the use on a wider scale of self-reducing tacheometers, particularly where datum points are altitudinally distant from the terrace fragments.

A completely different surveying instrument is shortly to be manufactured which could radically change the methods of terrace heighting. Neilson's Continuous Slope Profile Delineator produces a continuous graphical output of surface height similar in accuracy to tacheometric methods and very much quicker. The instrument is pushed, wheelbarrow fashion, between points with known coordinates and the variations in height are automatically recorded on graph paper by a pen connected to a damped pendulum. The use of this instrument, claimed to have an error of 1/500 in a vertical sense under the worst conditions, could enable complete grid or random traverse coverage of all terrace fragments in a valley to be accomplished in an acceptable time where few fences or ditches exist.

v). The Choice of Datum Levels.

All heights in a given system must be related to a common datum level to be comparable with one another. Several possible datum levels exist, most of which are ultimately related to sea level. Terraces are usually heighted with reference to one of the following:-

a) Present river surface datum. Examples of the use of this in the literature include Milne Home (1875), Eckford and Manson (1925), Bryan and Ray (1940) and Lacaille (1954). The advantages of such a datum level are that it is everywhere present along the valley and not usually far removed from the terrace features. Its disadvantages are few but overwhelming, springing in part from the variability of river regime. Differences between flood, winter and summer levels vary considerably even within one river system but are usually such as to cast doubt on correlations based on heights above the river surface taken at different times. Flood levels at any one time in the Tweed valley have varied from 8 feet above normal where the valley is broad to 19 or 20 feet elsewhere. Much more extreme examples are reported elsewhere - Lauder (1830) reported the River Findhorn rising 52 feet at one point in the great flood of 1829, while floods up to 90 feet above the normal level can occur in a few hours in the Yangtse Gorges. Such variability even on the much smaller scale associated with normal conditions makes the river surface a hazardous datum level.

If heighting above the river surface is unsuitable then converting all the figures into Ordnance Datum heights by heighting the river at other points, adjacent to bench marks or spot heights is even more to be deprecated. While in the case of very low gradient rivers it is possible to use the water surface as a datum in this way, such a practice on the Tweed and many other similar rivers is unwise as it can not be assumed that the river profile is at all regular between any two such control points unless they are very closely spaced and linked to gauging points. If the height of the normal river surface in relation to mean sea level is not known accurately, the calculated O.D. heights of the terraces will be extremely variable in their accuracy.

b) Alluvium or flood plain datum. Numerous workers (e.g. Clayton 1953a, Wooldridge and Linton 1955, Brice 1964) have heighted or quoted heights of terraces in relation to the alluvium or floodplain. Implicitly or explicitly, this datum has usually been justified by this argument: 'since only the present flood plain and past floodplains are comparable, there is no point heighting the present river and then past floodplains. The heights of previous rivers can be inferred by subtracting the present floodplain's height above river from the height of the former floodplains.'

Leaving aside the differences in floodplain formation in different climates, and the possible different relationships between such features and braided or single channel streams, there are many disadvantages derived from heighting with reference to a floodplain: irregularities in the present day floodplain need not necessarily have been repeated in the development of the higher, now relict features, especially where the river is now impinging on bedrock for the first time in it's post-glacial history in that area. Other factors responsible for such irregularities, hydrological, climatic or human influence, themselves variable in space and time, ensure that variations in height of a terrace above the 'alluvium' have no significance unless the variations in altitude of the latter are themselves known. As with heighting from the river surface, the cumulative effect of heighting from a feature such as the floodplain whose spatial and temporal variations are largely unknown, converting these figures into height above mean sea level and then correlating the features with previous supposed stillstands of the sea level is ludicrous except in the rarest of circumstances.

The use of the 'alluvium'as a datum assumes that it is everywhere a present day feature or at least synchronous. Given a circumstance where crossing terraces occur and a poor floodplain development occurs upstream of the crossing point, the higher terraces could well be heighted in terms of a feature at once older and possibly very different in origin to the so-called present-day floodplain. Indeed,even if conventional crossing terraces do not occur,a supposed floodplain may still be very much a diachronous feature. Thus if it be supposed for the purposes of argument that some of the very large number of papers on terraces related to nick-points are correct (Chapter 2) then the floodplains above and below the nickpoint are of different ages (e.g. Hutching's 1964 paper on the River Mole).

Evidence will be presented later to show that the floodplain is, in parts of the Tweed, of some antiquity and therefore even in the case where it is parallel to the present water surface, is not necessari -ly in close genetic relationship to the present river regime unless the latter has been remarkably constant for some time.

c). <u>Contours datum</u>. Heighting terraces in direct relation to mean sea level has long been advocated (e.g. Green 1936). The most conveniant means of accomplishing this is by measuring direct on the map or instrumentally in the field from contours. While this is legitimate practice where no better datum exists, the disadvantages of over-reliance on interpolated contours on Ordnance Survey maps are now clearly recognised (Peel 1949, Clayton 1953b). The limits of accuracy attainable in heighting from the photogrammetrically-plotted, 25 feet interval contours on the new Ordnance Survey 'six inch' sheets have not yet been determined.

d). Spot height datum. Assuming a spot height can be accurately located and is based on instrumental levelling, the maximum possible initial error in utilising it as a local datum level is 0.99 feet, correct to two decimal places. Exact location of spot heights is often a problem so this and the initial error could well result in closing errors between two different spot heights of the order of two feet (neglecting instrumental and observer errors) or indeed much more in cases where roads have been built up since the last survey, a not infrequent occurrence. A closing error of less than a foot should be looked on as fortuitous: next to heighting from Bench Marks or trigonometrical stations this is probably the best height control currently available.

e). Ordnance Survey Bench Mark datum. The bench mark offers many advantages as a datum level in geomorphological survey of most parts of Britain below 1,000 feet. In providing a universally constant datum, i.e. mean sea level, it is ideal where supposedly significant 'natural' datum levels such as river surfaces are suspected of introducing further variables into complex problems. The accuracy to within 0.03 feet (pers. comm.) is, strictly speaking, far greater than necessary for most practical purposes. Nonetheless, in levelling from a bench mark the final answer, depending only on a satisfactory closing error, is known to be more accurate than necessary, thereby eliminating a major variable in the 'uncertainty complex' surrounding terrace correlation.

The disadvantages of bench marks arise from their variable frequency and accuracy. In most populated areas they are said to exist at approximately 400 yard intervals along most roads. In low population density areas such as the Tweed Valley, this frequency is only attained or surpassed near the few large towns and in anomalous small rural areas. In several instances, bench marks exist only on one side of the valley while bridge frequency is of the order of one per five miles or lower; in such cases the height was 'carried' across the river by heighting onto convenient objects. Generally, this was not as great a problem as was first thought because the terrace sequence was usually detailed enough to demand loop traverses from the two bridges nearest to main road bench marks, meeting at the halfway point. Thus closing errors could be checked both within each loop and also between each loop mid-point. Temporary bench marks were frequently cut in fence posts, etc., so that several traverses could be 'tied in' at various points and the cumulative error continuously observed.

The third and most recent levelling in the Tweed Valley was carried out in 1953 - 54. Owing to changes in the importance of various roads since the previous levellings, the most recent bench marks are not infrequently in different areas to those from the earlier surveys. It was found convenient on some occasions to use the old Liverpool - based points for a datum level rather than the 1954 Newlyn-based ones; the heights of the former are given on old 'six inch' maps.

Overall conversion to Newlyn figures is difficult as the Ordnance

Survey have not yet calculated the correction factor for any part of the valley. Local corrections to data based on the older datum have been made wherever re-heighted Liverpool - based bench marks, not on 'six inch' sheets but marked on the 'twenty five inch' plans currently being published, have been discovered. Uncorrected data are suitably marked in appendix 1. The maximal difference found between Newlyn and Liverpool figures for the same bench mark in the Tweed area is approximately 0.6 feet and it is believed that this is likely to be the maximal error involved, most of the differences ranging between 0.3 and 0.4 feet. Newlyn - based heights are always greater than Liverpool - based ones.

Further potential errors exist where the site has been disturbed since the levelling took place: fortunately no mining subsidence is thought to have occurred in the area considered, there being little sub-surface mineral exploitation. One Liverpool - based bench mark was found inverted in the wall of a recently built house and while this is believed to be a rare occurrence, the system of interlinking traverses already described and closing on a second bench mark where possible enabled a strict check to be kept on possible errors.

C. Measurement of the Thickness of Terrasiform and other Drift Deposits.

While the main aim of this study was an examination of terraces as surfaces, it would have been unwise to have ignored any possible means of checking the conclusions reached. For this purpose, full notes (and samples where necessary) were taken at all exposures in superficial materials. A limited amount of hand boring was also carried out in suitable locations, while all the commercial bores in the public files of the Institute of Geological Sciences, along with others provided by consulting engineers, were collected, generally to gain some impression of variations in type and depth of superficial deposits but locally to calibrate or check values obtained from seismic investigations.

Approximately 70 traverses were run with a Soiltest 'Terra Scout' R 150 portable refraction seismograph and the tabulated results form appendix 4. The equipment and technique are adequately covered in many publications, among them Gough (1952), Mooney and Kaasa (1958), McGinnes and Kempton (1961), Dury (1962) and Al-Din (1963). Briefly the principle is that the ground is hammered and an electronic timer measures the time lapse between a signal proceeding instantaneously to the instrument via a cable and that travelling through the ground as a variety of wave forms (Plate 1). The hammering process is repeated at intervals of 5, 10 or 20 feet from the geophone, until either a series of graphed readings lie on a straight line or the signal received via the geophone becomes too weak to distinguish from 'noise', derived from passing traffic and other extraneous sources. A reverse traverse over the same course is necessary to detect interfaces sloping relative to the ground surface. Simple formulae convert the delay time and distance of hammering from the geophone into depths to seismically significant interfaces (junctions at which the velocity of sound suddenly changes). Maximal depths attainable vary with the nature of the deposit but may be as great as 100 feet without the use of explosives.

Being based on the principle of refraction between two bodies of different density, this seismograph can only pick out those cases where the velocity of sound increases with increasing depth. Fortunately, this is more normal than a velocity inversion but a reflection seismograph, unaffected by velocity inversions, would probably have many applications in studies of drift deposits. Tests against borehole control showed very accurate results of the order of $\pm$ 1 foot in 50 feet of sand over bedrock, while a few yards away a readvance till over the sands gave readings varying greatly in the amount of error (average velocities for till and dry sand are approximately 4,000 and 1,200 feet per second respectively). Empirical methods can be used, with experience, to detect the presence of a near-surface velocity inversion. Coster and Gerrard (1947) claimed an accuracy of ± 10 percent for their work, while Johnson (1953) obtained much smaller errors. It should be mentioned that most work has been carried out, including the latter reference, with a 12 channel machine, rather than a single channel, multiple hammering type such as the R 150 Terra Scout. Thus the attainable level of accuracy varies greatly depending on sub-surface conditions and noise but may be high under simple conditions with good borehole control.

Certain characteristic velocity ranges can be assigned to specific types of material, the width of the range being a function of the variability of the deposit and particularly of the water content in the case of coarse grained deposits. The simplest situation is a marked change in seismic velocities such as occurs where dry sands and gravels overlie moderate to high velocity bedrock such as greywacke or igneous materials. In more complex situations, such as where frequent silt and clay lenses exist in gravels, several interpretations are often possible and these can only be checked with borehole control. The lack of natural sections and engineering works in the Tweed valley ensures that a large percentage of the seismic traverse results not closely related to such control must be regarded as provisional at present. Nonetheless the general pattern of the stratigraphy in several cases of this nature has been confirmed subsequent to the completion of field work with the discovery of old bores or new sections.

Use of this equipment was mainly restricted to tackling two problems, namely the sub-surface morphology and stratigraphy of the terrasiform deposits and the location of the buried valley of the Tweed. While it proved extremely useful, the employment of resistivity equipment in association with the seismograph as a reconnaisance tool would have considerably reduced the time expended on the latter task. All geophone locations were located with a ten metre grid reference and were usually heighted in the same manner as the terraces themselves.

D. Other Field Data Collected.

i) Stone Counts. Concern was felt that any one surface may represent only a final slight 'bevelling' by one stream while the mass of the deposits underlying the surface was laid down by another. Clearly it is impossible to prove this never occurs, but an analysis of rock provenance was undertaken in a small area around the junction of the Rivers Tweed and Lyne where such a situation seemed a reasonable possibility.

This spot was selected not only on the basis of terrace layout but with a view to easy identification of rock types: the Tweed Valley material is virtually all greywacke, while a variety of sandstones, limestones and igneous rocks would be expected to occur in the Lyne Valley if the deposits were from the Central Lowlands. Samples were selected from the few exposures in as near random a manner as possible e.g. the effects of colour on selection were removed by picking material with closed eyes. The results are set out in appendix 5.

ii) Collection of organic samples for Radiocarbon dating. Despite the increasing evidence of datable organic materials in the thesis area (see Chapter 4) the only site containing such remains which could be located was at NT 983533, near Berwick upon Tweed. Here marine shells and sand were incorporated in till overlying outwash sands which overlie partly laminated clays (Gunn 1884, Sissons 1967b). Efforts to locate the peat between two tills in the Slitrig Water, mentioned by A. Geikie in 1863, were unsuccessful due to the growth of vegetation on surface wash, plus the addition of a small tipheap.

iii) Collection of organic deposits for pollen analysis. Dr. W.W. Newey kindly carried out an analysis of samples for pollen from the laminated clays at NT 983533 mentioned above. In addition, he analysed the pollen content of a peat layer underlying the supposed present Tweed floodplain at several locations in the Tweedhopefoot area.

CHAPTER 4

THE FIELD AREA

A. The Present Topography

The dominant characteristic of the present topography of the Tweed Basin is its smoothness, lacking in all but a few locations the craggy irregularities of much of Highland Scotland. The boundaries of this basin are the Lammermuir and Moorfoot Hills to the north, the Tweedsmuir Hills and Broughton Heights to the west and the Cheviot Hills in the south; these flat-topped hills respectively attain maximal altitudes of 1755, 2154, 2754 and 2676 feet. Interposed between the Cheviots and the coastal plain, and separated from the massif by the Till Valley, lies a north-north west-trending ridge of Fell Sandstone, attaining an altitude of about 600 feet in the Lowick area. This parallels the Northumbrian coastline and effectively constricts the mouth of the Tweed basin. Five major south-southeast flowing left bank tributaries of the Tweed exist, the longest of which, the river Lyne, completely breaches the northeast-trending regional watershed, rising in the similarly orientated Pentland Hills. Numerous north and northeast-flowing right bank tributaries occur, of which the largest are the rivers Till, Teviot and Ettrick and the Manor Water.

Within the basin itself, much of the ground below a plane falling from approximately 750 feet above sea level near Melrose to 3-400 feet in the Berwick area is dominated by orientated relief, most of it trending northeastward and resulting largely from the effects of glaciation. The generalised relief of the area is shown in figure 4.1.

The form of the immediate valley within which the Tweed itself flows is variable. Miller (1883) long ago recognised the alternation of gorge and terrace tracts along the river. From the headwaters at Tweed's Well, 97 miles from the sea and at 1250 feet O.D., as far downstream as Melrose, the valley cross-section approximates to a form midway between the well known V and U shaped valleys, and lacking interlocking spurs. The only exception is at Neidpath (234 406) where the broad U/V valley continues, now dry, around the south side of Cademuir Hill while the present river flows through a steep-sided, narrow and rocky gorge to the north. At Drumelzier, where the riverless Biggar Gap meets the present Tweed Valley, the combined valley for a short distance downstream from that point is clearly a continuation of the former, being very much larger than the latter. Around Stobo (183 377), the valley form is asymetrical and a modified V shape, due in part at last to the presence of large quantities of glacial deposits. Between Holylee (390 377) and the Tweed/Ettrick junction, the valley is the U/V composite form in cross-section but is very much narrower than elsewhere.

Three miles downstream from Melrose, the Tweed runs through the largest of its gorge tracts, in the 200 feet deep Bemersyde Gorge, emerging near Newtown St. Boswalls. Here the typical valley form changes to that of a broad undulating lowland, into which the river is incised by amounts varying from thirty to one hundred feet, the valley being steep-sided on the outside of meanders and gently terraced on the inside. Persisting almost as far as Tweedbank (700 333), this incised cross section is then replaced by that of a wide, dished valley in which well-developed low terraces are plentiful. Downstream from Cornhill, the incision into a broad undulating plain re-appears, persisting until very near the mouth of the river, from where a broad asymetric open V shape exists to the sea.

B. The Geological Environment

Four systems are represented in the geological succession (figure 4.2) that comprises the near-surface bedrock geology of the Tweed Basin. These extend from the Lower Ordovician (Arenig) to the Lower Carboniferous (Bernician) although Shiells and Dearman (1966) have suggested the existance of Dalradian rocks in the eastern part of the Southern Uplands on the basis of tectonic style. Some 90% of the areal extent of rockhead is composed of sedimentary strata.

The most recent account of the palaeogeography of the area in Ordovician and Silurian times is that by Walton (1965 p.204). Pringle (1948 p.5) divided the Southern Uplands rocks into three belts, only the more northerly two of which are relevant here. He described the central belt, underlying much of the western half of the Tweed basin, as largely composed of highly folded "Llandovery greywackes and shales in which the Ordovician strata occur along the axes of complex anticlinal folds as long, narrow boat-shaped inliers" orientated in the usual Caledonian northeast-south west alignment. This belt is separated from the northern belt of similarly folded supposed Arenig, Ashgillian and Caradocian rocks, whose lithologies include greywackes, shales, limestones and lavas, by a line from the Southern Upland Boundary Fault near Dunbar through Stobo that essentially demarcates the main outcrop of the Silurian/Ordovician junction.

The complex fold system in these rocks has been thought of since the time of Lapworth as repeated isoclines but Walton (1965) in the western and Shiells and Dearman (1966) in the eastern Southern Uplands have recognised a variety of fold types representing several folding episodes in the Caledonian orogeny.

The junction between the Silurian and the old Red Sandstone is unconformable throughout the Tweed basin due largely, according to Pringle (1948), to the massive pre-Upper Old Red Sandstone erosion. Waterston (1965 p.297) states that pre-Upper Old Red Sandstone earth movements resulted in uplift of the Southern Uplands relative to the Midland Valley and the initiation of southward flowing rivers, draining into a broad depression stretching from the Merse to the Solway Firth. These valleys and the depression were then at least partly filled by the Upper Old Red Sandstone sediments. Much of the present Leader Water valley coincides with the line of one of these Palaeozoic buried valleys, possibly owing part of its form to exhumation.

In a very significant proportion of the Lower Tweed, the subdrift surface is composed of Upper Old Red Sandstone, recently described by Waterston (1965 pp. 301-3) and Smith (1967). The latter stated that most of the sediments, fine grained well-sorted arenites and sub-arkoses, were deposited from a northern source on piedmont alluvial fans and in playas, typical of a semi-arid environment. In contrast to Waterston, he said that the junction between these rocks, and the lowest member of the overlying Carboniferous strata, the Cementstone Group, is of a transitional sedimentary nature. In specifying the type of sediment in the latter Group as lagoonal with fluvial bands and those of the succeeding Fell Sandstone and Scremerston Coal Group as shallow marine and fluvial with lagoonal bands respectively, Smith envisaged an environment in which slight changes of relative sea level occurred, culminating in the growth of a northerly-fed delta. The Cementstone

Groups lithology is chiefly thick sandstones separated by thin cementstones, mudstones and sandstones, while that of the Fell Sandstone is remarkable in being entirely a very well-sorted cross-stratified sandstone with very small quantities of mica and clay matrix. The Scremerston Coal Group is a complex of sandstones, mudstones, shales and cementstones. The palaeogeography of Southern Scotland at this time has been summarised by George (1960) while Eden and Smith (1966) have recently added to the known present geographic distribution of Carboniferous strata by tracing these sediments, existing on land at Dunbar and Berwick, out under the North Sea where they unite around the inlier of the Lammermuir Hills off St. Abb's Head.

Volcanic activity associated with the deposition of sediments was considerable in the Tweed basin in Upper Old Red Sandstone and, particularly, Lower Carboniferous times. The base of the Carboniferous underlying the Cementstone Group in the area between Trows (690 323) and Sprouston (757 353), consists of the Kelso Traps, olivine basalt plateau-type lavas, believed to have come from numerous vents. Their position in the river bed is marked by the occurrence of rapids (682 321). Several outcrops of extrusive and some intrusive igneous material (e.g. Eildon Hills), formed at comparable periods, constitute obvious elements of the present scenary due to their low relative erodibility compared with that of the surrounding sedimentary rocks.

Although throughout much of Lower Tweeddale the structure of the Old Red and Carboniferous strata is a simple shallow syncline whose axis runs in a north-easterly direction, slightly modified by local effects, considerable folding and faulting did occur in post-Lower Carboniferous times in the present coastal area, giving rise to the large east-facing Berwick monocline (Shiells and Dearman 1966) and the Fell Sandstone ridge previously described (Shiells 1963).

C. Tertiary Landscape Evolution

Evidence from other parts of the Southern Uplands suggests that the region suffered renewed uplift and denudation at the end of Lower Carboniferous times. Pringle (1948 p.51) pointed out that the outliers of Upper Old Red Sandstone suggest that the cover of these rocks was formerly much more extensive. Although there is no supporting stratigraphic evidence, it is a reasonable hypothesis that the region was at least partly covered by Upper Carboniferous, Jurassic, Cretaceous and possibly later rocks and that these have subsequently been stripped off.

The only rocks in this region intermediate in age between the Lower Carboniferous and Pleistocene periods, approximately 300 million years (Holmes 1964), are the Tertiary dykes. These have an extremely limited distribution in the Tweed basin but their importance is out of all proportion to their areal extent. The longest dyke is that first identified in the Tweed Basin about twenty five miles west of the Border and running east-southeastwards through Hawick, forming part of the Acklington dyke of Northumberland. Another cuts the headwaters of the Tweed at 056207. As George (1965 p.37) pointed out and as has been appreciated for many years, the fact that these dykes "nowhere serve as feeders to lavas preserved on the present surface but are themselves truncated by that surface" indicates that the summit surface in such areas is younger than the Tertiary dykes.

Any analysis of pre-Pleistocene drainage and landscape evolution in Northern Britain must accept a large measure of indeterminacy due to the non-preservation of vital evidence. In some cases much may be undiscovered and this is probably true in the Tweed basin where only one worker (Ogilvie 1951 p.14) has made any serious attempt to map erosion surfaces. Numerous early comments, ranging from those of Chambers (1848) and Milne Home (1875), both of whom believed all such flats to be marine in origin, to Goodchild (1902) who was convinced that rivers had played the major role in shaping hills in the Peebles area, are preserved in the literature but the only other comparable modern study is that of Common (1954) in the Cheviot Hills. Ogilvie recognised three main groups of surfaces, the summit Plateau (approximately 1800 feet O.D.), the Higher Lowland Peneplane (between 500 and 700 feet, rising to 1,200 feet in the Ettrick-Teviot area) and the Lower Lowland Peneplane (up to around 300 feet O.D.). He accepted that the last mentioned form was probably greatly influenced by glacial erosion. Ragg (1960 p.33) claimed to have recognised "traces of these (peneplains) ... at 2700, 2400, 2000, 1800, 1600, 1400 and 1000 feet".

As Sissons (1967 p.22) pointed out, views on the origin of the drainage systems of Scotland, in particular the origin of their present orientations rather than actual positions, can be subdivided into three categories. All of these have been built up in part from observations in the Tweed basin. The first of these categories, propounded by Mackinder (1902) and supported by Gregory (1915) and by Peach and Horne (1930) viewed the original drainage[1] as southeastward-flowing

1 The term original drainage is a misleading one; generally it is intended to mean the earliest drainage pattern of which evidence still exists.

streams, swinging eastward in their lower courses, running over a summit plane of low relief. Gregory (1915), accepting that the Clyde once joined the Tweed near Drumelzier, acquiesced with the opinion implicit in Mackinder's publication that this called for a reversal of the Lower Clyde. Sissons (1967a p.23), elaborating on the work of Linton (1933), noted two fundamental objections to this theory, that it fails to explain the numerous discordant streams which do not flow south-eastwards and also that the uplift and tilting of the plane of low relief, formed by subaerial erosion, according to Mackinder, would cause an incision of rivers in their existing courses rather than producing a new southeastward orientated system.

The Tweed, viewed on a large scale, is in part an eastward-flowing river, exhibiting marked indifference to structure in much of the Ordovician-Silurian belt. This pattern and the easterly diminution in summits, repeated over much of Eastern Scotland, led to a second interpretation of drainage evolution, initiated by Goodchild (1902 p.256) and culminating in the work of Linton (1933 1951). In essence the latter postulated that the original drainage of much of the Grampians and Southern Scotland was eastward flowing and is now partly dismembered. Originally, Linton (1933) suggested these rivers to have flowed on a surface of low relief but in later years he specifically identified the surface as the top of the Cenomanian rocks, now almost completely stripped from the Scottish mainland. Goodchild's views, that the drainage originated on a plane represented by the flat tops of the present hills, differed primarily in that he regarded these as being remnants of the sub-Cenomanian surface. His statements that the relief forms were due to the work of rivers but showed some signs of modification by ice action, and also that the surface was distorted and re-exposed by erosion of a large flat sheet of Cretaceous rocks, anticipated many of the conclusions derived in the following half-century. His views appear to have received little attention solely because of publication in an obscure journal.

In many respects the interpretation proposed by Linton represented a considerable advance over preceding theories. He suggested (1934) that the Upper Clyde, not a reversed Lower Clyde, flowed through the Biggar Gap to join the Tweed. The anomalous course of the Lyne, rising in the Pentland Hills and flowing south-eastwards into the Southern Uplands to join the Tweed four miles west of Peebles, was explained by reconstructing the supposed 'original' water watershed. He suggested that rather than lying southwest to northeast as at present, this lay approximately from west to east, from the eastern Lammermuirs to the Pentland Hills. The removal of the cover rocks exhumed the northeast-southwest watershed, but superimposition of the rivers from the surface of these rocks and the persistence of the river courses led to the present pattern of an increasing tendency to breaching of the watershed towards the west. Thus the greater penetration of the Gala Water into the Southern Uplands than the Leader Water was explained, likewise that of the Eddleston in comparison with the Gala and so on.

Partly from the considerable local variation in drainage orientation in southern Scotland, related in Sissons' words more "to the present distribution of high ground than an eastward tilted surface" (1967a p.23) and more particularly from geological evidence denying the existence of fundamentals of the Lintonian scheme in north-west Scotland, a third explanation of drainage origin is current, recently developed by George (1955, 1965 p.37). He proposes that rather than an 'initial' unidirectional drainage system, water dispersal was controlled by the emergence of stepped marine erosion surfaces following a mid-Tertiary submergence. Thus, as it is believed that little major subsequent change in landforms has occurred, many Scottish rviers still reflect the orientations of the slopes on which they flowed when first the sea level fell. The clear evidence that at least some of the erosion surfaces post-date the Tertiary dykes has already been noted while the stepped nature of the platforms can be illustrated by projected profiles derived from Ordnance Survey maps (e.g. George 1966 p.22).

Hallam (1965 p.401) stated that there are virtually no known Tertiary marine sediments in Scotland. Thus, as Sissons pointed out (1967a p.24), there is no stratigraphic evidence of the marine submergence required by George. Furthermore, the implicit denial of any significant post-mid-Tertiary distortions of the erosion surfaces as shown in the projected profiles and the subjectivity inherent in the construction of such profiles suggests caution is necessary in accepting the conclusions. It is debatable whether hill tops can be employed to represent the remains of a surface on a local scale and over wider areas where varying lithologies are found.

Sissons (1967a p.25) combined certain aspects of both the work of Linton and George in his recent synthesis of Tertiary landscape evolution. This is based on the proposition that the 'initial' watershed separating streams draining to the North Sea and those draining westward was broadly similar in location to the present equivalent and was the axial plane of a country wide anticline. At this time both sea and land level stood far above their present values, the greater height of the land being due in part to the extensive cover of chalk and other sedimentary rocks. As the sea level fell, rivers commenced to flow on the exposed sections and subaerial slope retreat continued the work of previous marine erosion in stripping the cover rocks and modifying the surface of those beneath. Sissons postulates that this commenced in early Tertiary times and was substantially modified in the northwest by the mid-Tertiary epeirogenesis.

While the best synthesis available at present, this account still poses numerous problems. It still demands a marine submergence of which there remains no known stratigraphic evidence. Furthermore, presented on a countrywide scale (Sissons 1967a p.25), it is difficult to interpret the supposed 'initial' form of any one river: the Tweed, for example, was shown to have the present river Lyne as its headwaters. Thus Linton's original east to west watershed in this area was accepted but nothing was shown of the present Upper Tweed Valley or the problematic Biggar Gap, save a later reference (p.42) to this as a possible glacial breach in parts.

The lack of accurate field work and the suspected lack of actual evidence severely limit the validity of any conclusions on the early geomorphic evolution of the Tweed Valley. Rather more evidence is available to aid the interpretation of events in this area in Pleistocene times.

D. Pleistocene Landscape Evolution Prior to the Last Deglacierisation

(i) The Forms of Glacial Erosion

Much of the brilliant early work and fevered debates on the origin of features now known to be associated with the Pleistocene glaciations took place in relation to evidence in the Tweed basin.

Much of the early work was devoted to study of the drift but erosional features were not neglected. While many workers such as Goodchild (1902) were happy to attribute the form of several parts of the Tweed valley to modification by ice, vehement opposition to this was provided by the Protectionist, J.W. Gregory (1915). As part of his evidence, he quoted the form of Pirn Craig, the extremity of a spur between the Tweed and its tributary, the Leithen Water, isolated by a vertical incision from the main mass of rock. He apparently did not appreciate both the possibility that this might be in part at least a fluvioglacial feature and also the extreme selectivity of ice in eroding.

While Pringle (1948 p.80) re-emphasised a valid and long appreciated point that, as the majority of the drift in this area exists in the valleys, the latter must therefore predate the last glaciation or, more accurately, the last deglacierisation, there is clear evidence that some sections of many valleys have been very considerably altered by this or previous glaciations. The Talla trough, now occupied by a reservoir, is an impressive glacial gouge surrounded by the rounded hill slopes formed, according to Geikie (1865) and Goodchild (1902), by fluvial agents and slightly modified by ice action if the latter is correct. The importance of lithology often appears to have been neglected in early studies: there is good reason to believe that the finely-bedded shales and perhaps the greywackes of much of the Southern Uplands might give similar landforms where subjected to fluvial and non-concentrated glacial erosion.

A site investigation report on possible dam sites in the Southern Uplands for Edinburgh Corporation by Rock Mechanics (1967) showed that the rock floor of the Megget is over 80 feet below the ground surface at Shielhope (194 221), rising to approximately 20 feet below the surface at Cramalt (201 225), some 800 yards downvalley. As the surface diminution in height over this downvalley distance is no greater than 15 to 20 feet, a minimum of 40 feet of overdeepening has occurred. A similar downvalley rise of 60 feet in the bedrock floor occurs in a horizontal distance of 650 feet at the east end of St. Marys Loch.

Other undoubted evidence of glacial erosion is provided by the presence of corries, including that containing Loch Skene. Goodchild (1902) believed the Tweed Valley upstream of Neidpath Gorge to have been excavated to a depth of 100 feet or more in comparison with the gorge section, apparently not realising the importance of differences in age between different sections of the valley. Sissons (1967a p.42) suggestion that the Biggar Gap may in part be due to glacial diffluence has already been noted.

Distortion and disruption of rockhead has been recorded within the field area by at least two observers. J. Geikie (1874 p.21) described flowage and distortion of near-vertical shale bands of Silurian age near Peebles due to the pressure of superincumbent moving ice, confirming the plausibility of glacial erosion in such lithologies. He also noted fracturing of sandstone and injection of till into the joints at Union Bridge (935 511). Stevenson (1874) recorded similar disruptions, describing the presence of a shattered layer of sandstone several feet thick, partly incorporated in the overlying hill at Langton, near Duns. A section recently examined by the author at Collar Heugh (865 416) showed up to 15 feet of an unstratified silty clay, containing rounded stones, overlying 20 feet of shales which in turn overlie 70 feet of massive limestone. The shales are highly shattered, particularly towards the junction with the till which is diffuse. Only 100 yards away, the shales are completely missing.

Ice-streamlined features are a notable feature of the Tweed basin. While believed to be formed largely of till in the Merse, most of these landforms are cut in Silurian and Old Red Sandstone rocks in the area from about Melrose as far east as Smailholm. The marked orientation of relief in fairly homogeneous lithologies may reflect the coincidence of the strike of the strata and the direction of ice movement at one or more stages. The igneous intrusions and extrusions already described give rise to similarly orientated ridges, usually crag and tails. Examples of this include Eildon Hill North (Smith 1929), Black Hill (585 370) and White Hill (578 377).

This orientated relief, of varying internal constitution, is illustrated in figure 4.3, together with striae culled from all available sources, including the Geological Survey Maps and memoirs and numerous short notes in the local literature. Such minor features as striae are rarely preserved on much of the Carboniferous and Old Red strata, finding their best expression on outcrops of greywackes, Kelso Traps and igneous intrusions. The orientated relief shown is based on that shown on hachured one inch O.S. maps and on field mapping.

(ii) <u>The Forms of Glacial Deposition: till distribution, constitution and thickness</u>

In common with that on the evidence of glacial erosion, discussion on drift landforms of the Tweed Basin was active in the mid- and late-nineteenth century. The early appreciation of the significance of accurate recording of sections in drift is illustrated by the six points of guidance suggested by Anon (1862), for those engaged in cutting sections for the Berwickshire Railway. These points still form the basis of any study of a section and can be summarised as:

1) Are the rocks smoothed or striated? If so, note the direction.
2) Note the lithology.
3) Preserve and accurately locate any fossils.
4) Note if clays are stoneless or otherwise and the size of any stones.
5) Note if boulders are scratched.
6) If boulders are elongate note the direction in which each is pointing and the main orientation.

The generalised distribution of till and other drift in the Tweed basin, compiled from a number of sources, is shown in figure 4.4. The extensive nature of the former is at once apparent, particularly as it is known to underlie other deposits in some areas. Little work has been carried out in the area on the accurate definition of till boundaries or on variations within or between different tills. Ragg (1960 p.36 and p.162) gave the typical clay fraction in the Berwick to Lauder area as about 40 per cent. of the till, but within some parts, particularly around Paxton and Hutton (908 538), the clay content rises as high as 50-60 per cent. His generalised description of the till covering much of Lower Tweeddale on which the Whitsome Soil Association is based is as follows:

"Reddish brown (5YR 4/3) clay: massive: plastic: rounded and sub-rounded stones of fresh and weathered greywacke and basalt; also fragments of coal, red and pale coloured sandstones and shales, felsite and andesite. Considerable variations in colours, stone content and particle size do occur, however".

Ragg also recorded (p.41) a "sandy till" of the Hobkirk Association and an equivalent, deeper clay loam till. It is possible that the first is an ablation till while the latter is of the lodgement variety. (Flint 1957 p.120, Sissons 1967a p.64) Local vertical variations in till are shown in section 1 (appendix 6), seen in a landslip face near Berwick, where the lowest exposed till member is extremely stoney while that at a higher level has relatively few stones and is much more plastic in a wet state.

One of the obvious characteristics of till in this area, (Gregory 1915, Carruthers 1932, Rock Mechanics 1967, etc.) is the ubiquity of rounded stones included. Very rarely, except where frost shattering has subsequently taken place, are angular or sub-angular stones found. Presumably this is due to the local ice incorporating previous fluvial or fluvioglacial deposits as it advanced downvalley.

A large percentage of the stones in the till are very local in origin. Yet the erratic content is often important, even if insignificant in terms of bulk: Ragg (1960 p.37) noted that Ordovician and Silurian greywackes are quite a common minor constituent of the till parent material of the Whitsome Association of Lower Tweeddale, confirming the general principle of a generally west to east ice movement over the region. Figure 4.5 shows the recorded erratics, based largely on the Boulder Committee Report for Scotland (Milne Home 1885), numerous short notes in the History of the Berwickshire Naturalists Club and personal observation. Not included on this map are Carboniferous corals derived from the Midland Valley, found near Duns by A.G. Long (pers. comm.)

In some areas the till sheet remains essentially flat in its surface expression but the dominant characteristic of its form throughout the Merse is its drumlinised nature. Apart from early maps, such as that in Milne Home (1875) and brief references to the drumlin field (Gunn 1895 and 1897, Fowler 1926, Carruthers 1932, Sissons 1967a p.86, Clapperton 1967 p.295) no publication has dealt with the Tweed drumlins in any detail. Yet a detailed study might conceivably necessitate a revision of present concepts of drumlin morphology and orientation, as well as providing more detailed evidence of local ice movement directions. For example, many drumlins were observed to be markedly flat-topped, such as that at 798 393, while the highly elongate form of all these features contrasts with the forms common elsewhere in parts of Scotland. A study of certain aspects of these features is being undertaken by Dr. J.B. Sissons (pers. comm.).

While argument raged in the second half of the nineteenth century, Milne Home and others upholding the diluvialist origin on these features, the only discord over their origin in this century was struck by J.W. Gregory (1926). He attributed their form to erosion by wind of a sheet of boulder clay. His evidence for this was a number of distorted trees on top of the drumlins, their orientation supposedly concurring with that of the landform, and also that the drumlin orientations were in some areas up to 40 degrees at variance with maps of ice movement directions by A. Geikie (1901 p.306)and Wright (1914 p.49). The developments in geomorphological knowledge subsequent, and to some extent prior to 1926, render it impossible to take this hypothesis seriously, although his criticism of the long-accepted maps does have some substance.

Evidence is available to indicate that local and perhaps regional variations in depth of till occur but this is not yet sufficient to permit a regional map of such variations. Ragg (1960 p.43) noted that "..exposures in stream and river sections show this till to be many feet thick but this is not general throughout Lower Tweeddale. The till thins to 3 feet or less in some patches around Swinton and Whitsome and in a belt 1 mile wide by 5 miles long northeast of Fogo." Personal observations along with unpublished bore records of river sections in this part of the Tweed basin suggest the depth of till is normally between five and thirty feet. The oldest known bore in the field area, carried out in 1816 at Kellytown, near Maxton, typifies the situation away from drumlinised areas in showing 9½ feet of till over rock. Carruthers (1932) made the point that south of the Tweed and east of the river Till, excluding the drumlins, the till was generally thin while in the Cornhill area thicknesses of 25 feet are not uncommon. Borehole evidence suggests that in the valley bottoms in the Upper Tweed basin thicker deposits of till sometimes occur. Several bores in the vicinity of the Lewinshope Burn, near Selkirk, showed up to 50 feet of till while others for the Broomlee to Broughton section of the Talla aqueduct frequently found 25 feet of till without reaching rock.

A frequently expressed generalisation concerning this area is that throughout, the drift is thicker on the west compared with the east side of north-south orientated valleys (Pringle 1948, Ragg 1960) This has been interpreted as evidence for a westerly origin of the ice, depositing till on the lee face and eroding the stoss slopes. Marked examples of this noted in the course of field work are the valleys of the Walker and Plora Burns, running south and north respectively towards Walkerburn. A similar case, if in a different orientation, is known from the Heriot Water near Garvald (Rock

Mechanics 1967). Investigations revealed 100 feet of till with sand and gravel bands on the south side of the river, compared with a thickness of approximately 20 feet on the north side.

Long sections of many valley bottoms in the Tweed basin appear to be wholly or partly buried by glacial or fluvioglacial materials. Thus, at Posso Craig in the Manor Water (204 317), an old bore passed through 149 feet of clayey and stoney drift on top of rock while the recent Rock Mechanics (1967) report on dam sites in the field area contains sections which show the depths to rockhead at Langhaugh (202 310) and Kingscairn (204 316) to be 74 and 115 feet respectively. It is likely, however, that this includes solifluction materials. The present valley of the Slitrig Water, according to A. Geikie (1863), contains at least 100 feet of till in some parts. Figure 4.6 represents sections obtained by bores across the Talla and Fruid valleys, carried out in 1893 in connection with reservoir site investigations. Plans to build a dam across the Upper Tweed Valley were dropped shortly before a site investigation was begun. Presumably because of the smaller amount of infill (shown in sections a) and b)) in the Talla, most of which comprised mixed deposits including till, sand, gravel and earth and stones, this site was chosen in preference to that proposed in the Fruid.

Geikie also believed that completely buried valleys existed in the Tweed basin, entirely plugged by drift. On the original 6 inch field maps for the Middle Tweed around Melrose he showed a sinuous valley of this type, apparently based on such sections as the following, examined in 1967 at Newstead (566 344):

Approximately 60 feet of medium brown till with rounded stones sharp junction

25 feet of coarse rounded gravels in sand matrix

rivers edge.

Presumably it is from sources such as this that the rounded stones incorporated in the overlying till are derived. This section is shown in Plate 18, while Plate 17 illustrates the comparable situation at Mertoun Mill (609 324) where gravel lenses are found in the till. While (vertically) thick exposures of till at 558 350 and 572 348 are no proof of buried valleys, being probably only a thick veneer of drift on the valley side, the full exposures at Newstead (Section 3 appendix 6) and at Mertoun Mill (Section 2) might seem to suggest the existence of now-plugged valleys cut in bedrock. Brief seismic investigation at the latter location (Sets 37 and 38 in appendix 4) would appear to render such an interpretation questionable on present evidence as it seems that the rockhead, for a short distance at least, parallels the rapid surface rise towards the northeast. It is possible, however, that the section represents a highly oblique section across a completely buried valley. The existence of other such valleys is suggested elsewhere in the Tweed valley by anomalous bores such as that quoted by Gunn (1895), which located 250 yards southeast of Wark East Common in an interdrumlin area, showed 102 feet of "clay" without reaching bedrock.

Variations in till thickness can be due to changes in altitude of rockhead or of the till surface or both. The borehole noted above is only anomalous because in virtually all recorded sections (e.g. Fowler 1926) the drumlins are composed of till, including rounded stones, while the interdrumlin areas appear to have a relatively thin cover of till. While not directly comparable, a bore at 6843 4042

(Carter 1966 p.36), located between two crag and tails, showed 14 feet of sandy boulder clay over rock while another in front of the southern ridge, at 6834 3992, some 600 yards to the south, showed 73 feet of till without reaching rock. Several poor sections are known which show moderate thicknesses of till in drumlins often resting in bedrock, such as that at 8575 3892 where 25 feet of silty clay resting on rock is exposed at the base of a drumlin.

Outside the area mapped in the present study, along the Northumbrian coast and inland as far as the Cheviots, two tills have long been known (Smythe 1912, Fowler 1926, Carruthers 1932, Parsons 1966, Clapperton 1967 p.6). In places where both tills are present the sequence is, according to Fowler (1926), typically:

Upper clay-fewer stones than lower equivalent, but often of distant source.

Undisturbed junction.

Bedded sand and gravel (from 1 inch to 1 foot diameter)

Undisturbed junction.

Lower clay-local stones, often large, rock head often disrupted.

He also stated that laminated clays are often found in the 'Upper Clay'. Clapperton (1967 p. 18) recorded a section of two tills in the Shipley Burn separated both by sand and gravel and by laminated clays. Carruthers (1932) interpreted this general succession as a monoglacial sequence, the 'upper clay' being ablation moraine, a conclusion accepted by Clapperton (1967 p.8)

Evidence of multiple tills and intercalated sediments inside the Tweed basin is much more poorly documented. One of the most interesting sections, described by J. Geikie (1874 p.158) from the

Leithen Water, showed two tills, the upper of which was unconformable on an eroded surface composed of contorted sediments and the lower till (Section 4 in appendix 6). A borehole drilled in the course of the site investigation for the Tweedside Co-operative Store in Berwick (999 528) revealed the following succession:

7' 0"	Made ground
10' 9"	Brown boulder clay
14' 9"	Grey boulder clay
	Grey mudstone

In his classic original work, A. Geikie (1863) reported the following section at 508 135 in the Slitrig Water near Hawick:

30-40'	Till
	Yellow grey sand
"a few inches"	peaty silt and clay+heath plant remains
	fine ferruginous sand
2-3'	coarse shingle
15-20'	coarse stiff till
	river surface

The considerable importance of this section is obvious, representing the possibility of providing a maximal age for the upper till in this area by C14 dating of the plant remains. Field evidence suggests there is no possibility of the upper till not being in situ. Unfortunately, attempts to dig out the section proved abortive owing to the present cover of trees and the addition of a small tip heap.

Another important section was noted by J. Geikie (1894 p.96 and

and p.119) on the upstream side of Neidpath Gorge (234 403) and subsequently by Eckford and Manson (1927) when a landslip re-exposed the deposits. Here till, including striated stones, overlies laminated, gutta percha clays and this in turn overlies horizontally bedded sands and gravels. The junction between the till and laminated clays is sharp and the whole sequence, when originally seen, extended vertically for 50 feet above the river Tweed. J. Geikie, while offering no proof, believed another till to underlie the sands and gravels and stated that traces of the stratified beds had been found in and below the upper till for some distance up the Tweed Valley. Eckford and Manson (1927) found no evidence of any till in their section. It is possible that Geikie's upper till may not be insitu as the hill slopes in this area are steep.

Several bores listed in Carter (1966) show 'boulder clay' from 5 to 52 feet thick and incorporating layers of sand or gravel. Others exist (e.g. 25/220 on p.44 and 25/103 on p.48, Carter 1966) which show thick till overlying thick sand and gravel but with no underlying till, identical to the situation at Mertoun Mill. Sections 3 to 7 in Appendix 6 describe several examples of till overlying sand, noted in the course of field work.

iii) The Sequence of Events in the Glacial History of the Tweed Basin

While available evidence is much more sparse in the Tweed Basin compared with that in the Midland Valley of Scotland, it is possible and desirable to outline a broad sequence of events. All previous accounts either suffer from a lack of available detail or are fragmentary and even inaccurate. As Gregory (1926) pointed out, the long accepted map of ice movement direction is, in places, up to 40° at variance with the drumlins. Only in Ragg (1960 p.33) is the usual description of this "Map showing direction of ice movement in the South of Scotland" (Pringle 1948 p.81) qualified by the prefix 'Generalised'.

No interglacial deposits are known in the Tweed Valley as a whole; those in the Slitrig Water are probably interstadial. While it is possible that many of the landforms are in part relict features dating from an earlier glaciation, it must be assumed for the moment that all were created in the last glaciation. Multiple till sequences do not necessarily indicate anything other than a change in direction of the overlying ice, and my sometimes even be independent of that.

The presence of rocks of Highland origin such as schist, gneiss (Goodchild 1902) and possibly granite associated with recent finds of Midland Valley Carboniferous corals in Tweeddale are the main evidence for what Sissons (1967a p.126) has termed 'the maximal' glaciation in this area. Presumably at some stage subsequent to the maximal glaciation, the next known stage is that represented by section 1 (appendix 6) near Berwick (9827 5329). This shows till overlying sands which apparently dip from west to east and in turn overlie clays, laminated in part. A channel, revealed in cross profile on the section, has been eroded in the clays and filled with sand. Augering revealed at last 7 feet of these clays, while an analysis of their pollen content by Dr. W.W. Newey yielded only Pine species, although Carboniferous plant spores were common. Recent examination of this section showed the shell fragments incorporated in the till to be apparently unstriated although Gunn (1884), in listing 13 species of mollusca and derived Cretaceous belemnite fragments from now obscured sections, noted that many were smoothed and one, Cyprina Islandica, was striated. At present, the shell fragments are found in greatest abundance in a contorted lens of sand incorporated in the till (Plate 2) However, other well preserved fragments were found high in the overlying till. A thin section of this till, taken from a specimen cut approximately 6 feet from the surface of an ice-moulded ridge, at about 90 feet O.D. (the gravel band occurs between 71 and 74 feet O.D.) and impregnated by J. Rose, showed shell fragments and many coal erratics. Coal is also common in the underlying sands. A C14 date of greater than 41,000 years B.P. has been obtained for those shells (Sissons 1967b). Clearly, therefore, both underlying sand and laminated clays are older than this, although by an unknown amount. Proof that the laminated clays are not purely local was given by Fowler (1926). He recorded that at Mill Farm (989 528), some 500 yards distant on the opposite bank of the river, exposures in a clay pit revealed 15 feet of partly laminated clay, brown to red in colour but lighter on another face of the pit.

The orientations derived from four observations of 100 orientated fragments taken from the thin section of till, that obtained by combining all 400 observations and a macro-fabric obtained by digging a pit in the crest of the ridge are reproduced in mirror image rose diagram form as figure 4.7. Apart from a fairly obvious northeasterly trend on several of these diagrams, at right angles to the crestline of the ridge, no clearly marked consistent orientation is present. That repeated sampling from the same slide[1] does not show comparable results is probably due to one

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1 - Considerable care was exercised in ensuring that the sampling was done on a rigorous basis. The slide was projected onto graph paper and orientated fragments were delineated by their long axis systematically following grid lines on the graph paper until 100

over/

1. fragments were thus located. This process was then repeated by swivelling the slide to test whether visual definition of what were orientated fragments affected the final orientation. No flow patterns were noted in the slide. The macro-fabric orientation is clearly anomalous, even with respect to the varying micro-fabric. It seems likely that this was obtained from a weathered zone, close to the surface and therefore lacks significance; thus it is a result of weathering and the field technique as much as of the original fabric.

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of the following factors:

a) the sampling technique is biased by some factor.

b) flow structures are present in the till, causing considerable local differences in the micro-fabric.

c) this is an atypical till and little preferred orientation exists.

From this evidence it is possible to compile a crude sequence of events in the area from more than 40,000 years ago up to the present day. The absolute dating provided by the C14 determination from the shells must, however, be regarded as circumspect in view of the considerable technical difficulties involved in treating shelley material (Shotton 1966). The clays must either have been deposited in an estuarine environment, similar to that in which the Late-Glacial 'raised beaches' of the Forth estuary formed, or in a lake. The only possible barrier to hold up such a lake in the lowest reaches of the valley is foreign ice existing along the line of the present North Sea coast.

Subsequent to this, the sands were deposited but whether these are marine or fluvial and, if the latter, from direction they came, is as yet unknown. It may be possible to elucidate this problem by determining whether any foraminifera or other marine micro-fabric exists within the sands. Although some of the shells incorporated in the overlying till are littoral species, the deeper-water nature of some of the others associated with the presence of belemnite fragments recorded by Gunn strongly suggests an ice movement, post-dating the deposition of the sands, onto land.

The present river course, culminating in a large meander in the estuarine area, is deceptive when attempting to reconstruct the path of 'Foreign'[1] ice pushing up the Tweed Valley. The presence of a marked wave-cut bench at present mean sea level inside the estuarine area, associated with the total lack of coastal rock outcrops above this level as far north as NU 004 529, suggests that this platform passes under the till and blown sand deposits, extending a short distance inland. Much of the lower part of Berwick is underlain by post-glacial deposits and thus the physiography of the estuarine area was probably significantly different at this time. The simplest ice movement, requiring the minimal rise and fall over bedrock topography to carry shells from an offshore position to the site of section 1 would be east-southeast to west-southwest. Alternatively, the ice may have overriden the north to south orientated ridge, on which Berwick now stands, from a variety of directions. The more northerly the source the greater is the overland distance of transport and also the greater the required rise and fall of the basal ice (rock cliffs 60 feet high in the Berwick area increase in height up to 200 feet near Marshall Meadows (983 567)

1 - used in this case to denote all ice which did not all originate within the Tweed Basin.

The cause of this ice movement onto the coast may be explained by invoking the presence of Scandanavian ice some small distance off the present shore in the North Sea Basin. Thus the onshore movement could be composed entirely of this ice or be a function of it, causing Scottish ice to be deflected respectively south and north on emission from the Forth Valley and then landward in the Berwick area. Direct proof of this is lacking, in contrast with parts of the Durham coast where Scandanavian erratics have long been known (e.g. Trechman 1931) Clapperton (1967 p.10) has hypothesised that the presence of Scandanavian ice may not have been necessary to cause the deflection of a combined mass of Highland and Southern Upland ice flowing out of the Forth Valley.

The continued presence of offshore foreign ice has also been suggested (e.g. J. Geikie 1876) to account for the trend of the drumlins (figure 4.3) apparently formed by the last ice in the area (Sissons 1965 p.379). These seem to be mainly related to ice moving down the Teviot valley, merging with Tweed ice and flowing in a broadly southwest to northeast direction, gradually turning clockwise to flow from west to east in the Berwick area and apparently swinging a little southward between Berwick and Ancroft (NU 002 452). Those erratics originating in the Tweed Basin (figure 4.5) and the striae (figure 4.3) generally agree with this pattern, illustrated in figure 4.8.

Two important qualifications must be made about this evidence. The first of these is deduced from the evidence at the shelly till section at Berwick (9827 5329). As shell fragments have been found high in the till, quite close to the surface of an ice-moulded ridge which is orientated at 115 degrees (true north) and is clearly related to a downvalley ice movement, these may be derived from the lower sections of the till, presumably deposited by ice moving up valley. The alternative explanation, that the last ice movement in this area only remoulded the existing till without substantially adding to it, implies that in some places the ice-moulded features mapped may be diachronous. Indeed the lack of any consistent clearly defined microfabric as already discussed, may support the concept of the partial remoulding of these upper parts of the till by the westerly origin ice, having been first soaked to a plastic state by proglacial meltwaters.

The second qualification concerns the nature of the evidence: in the triangle whose apices are Berwick, Coldstream and Belford, little detailed mapping of the ice-moulded forms has been carried out, except by Clapperton (1967) in the southwest and by the author adjacent to the Tweed. There is well documented evidence for an approximately north north-west to south south-east ice movement parallel to the present coast, illustrated by the glacial gouges and striae on St. Abb's Head to the north (Tate 1865, Milne Home 1865) and to the south by crag and tails, striae and meltwater systems (Parsons 1966). However, because of a lack of field-work in the critical triangular area, there is no proof that the ice responsible for this orientated relief and that for the Tweed drumlins were contemporaneous. An analysis of contour orientations, as carried out by Burke (1966) in the Forth Valley or field mapping of ridge crests might settle the issue but as yet there is nothing to prove that the Tweed drumlins are younger in age than the orientated relief of the Northumbrian and Berwickshire coasts, as Sissons (1965 p.478) implicitly suggested in constructing his limits for the Aberdeen Lammermuir Readvance and assigning the drumlins to this period, having since reiterated this explicitly (1967a p.131).

The discovery by Smythe (1912) of crossing striae in several locations, the older indicating an ice movement from west to east while the younger concorded with the trend of the present coastline suggests that, if Sissons is correct, evidence of three different ice movements may exist. Supporting this interpretation is the section described by J. Geikie (1874 p.208) from the cliffs near Berwick. He described finding comminuted shell fragments in a 'boulder clay' overlying gravel which in turn overlies till at this spot. If this shelly drift and that already described from the Plantation (9827 5329) can be equated, the lower till probably indicates an earlier (a third) ice movement.

Sissons is at present the only worker to have suggested an absolute date for the formation of these landforms. By tentatively linking them with the Aberdeen-Lammermuir Readvance and subsequently (Sissons 1967a p.378) dating this elsewhere as occurring between 17 and 20,000 years ago, he has given an aproximate value for their age. Parsons (1966), equally tentatively, suggested they might be related to the Scottish Readvance (Penny 1964), itself poorly substantiated outside Cumberland.

Events in the Tweed Valley subsequent to the formation of the drumlins and coinciding with the first manifestations of deglaciation are still little known but of considerable importance and will be considered in subsequent Chapters. Several obvious derangements and re-routings of drainage have occurred in the drainage basin and as it is not usually clear at what stage most occurred, one at least predating the last local glaciation, the evidence for them will be reviewed here.

iv) Drainage Diversions in the Tweed Basin

The best known dislocation of former drainage in the field area occurs in the vicinity of Neidpath Gorge. The drift stratigraphy on the upstream side of this gorge has already been described, while the gorge itself is a narrow defile, cut in rock (Plate 25) on the northern side of Cademuir Hill. Recent field work showed that deposits were almost entirely lacking east of the gorge as high as 600 feet although fluvioglacial deposits are common above this altitude. No striae were found on the apparently resistant rocks exposed under Neidpath Castle. To the south side of Cademuir hill runs a broad drift-floored valley (J. Geikie 1874 p.181), now dry and highest near its mid-point at 232 368. A section at 2179 3672 in this drift showed the following sequence, underlying a 10 degree surface slope:

7 to 10 feet sandy clay with rounded stones, no stratification.
indistinct boundary
20 feet coarse gravel (2" or more in diameter) with some sand and finer gravel lenses.
Manor Water surface.

The upper layer of sandy clay is interpreted as till or solifluction material. No bedrock was exposed in the vicinity. Three double (forward and reverse spreads) seismic refraction traverses were carried out in the bottom of the dry valley, the mid-points between each pair of geophone locations lying at 2213 3644, 2416 3677 and 3535 3779, the data derived being tabulated in appendix 4. The first of these , sets 31 and 32 taken on flat ground some 500 yards from the section suggested the following stratigraphy:

8.8 feet sand and gravel

23.2 feet till or saturated sand and gravel

exceptionally compact till

The two interfaces between layers 1 and 2 and 2 and 3 also dip, relative to the ground surface, from east to west.

The third pair of traverses, sets 35 and 36 provided results which suggested the following interpretation:

7.5 feet sand and gravel

till

The minimal depth of till, calculated by assuming a value of 10,000 feet per second (similar to values obtained on rock outcrops elsewhere in the area) for bedrock is approximately 49 feet.

Sets 33 and 34, the second pair of traverses, were unsatisfactory in that considerable breaks occurred in the time/distance graph. Figure 4.9 illustrates the graph obtained in comparison with the satisfactory graph from sets 35 and 36. Such discontinuities, formed when it was found impossible to obtain a lower or higher reading comparable to the previous range of values obtained, were noted by Johnson (1954) and ascribed by him to local velocity inversions. This explanation, invoking, say, a shallow lens of clay within sand and gravel is also accepted by W. McKnight, a geophysical consultant (pers. comm.), although other workers have suggested the presence of buried channels or instrument failure as alternative causes.

Despite this unsatisfactory result, seismic evidence tends to confirm that a substantial volume of glacial and fluvioglacial deposits exists in the Cademuir channel. Long ago, the younger Geikie (1874 p.182) said that this channel was paved with river gravels and that the Tweed once flowed through it, diverted by "the alterations of surface brought about by the massive glacier that cut through the

the gutta percha clays and deposited the tumultous mass of till above them, and the modifications of level induced by denudation in later glacial times." A development of this argument would be that ice, advancing down the Manor Water valley,blocked the old course of the Tweed to the south of Cademuir Hill. This led to the formation of a lake in the Tweed Valley, perhaps extending as far up valley as the nearby Tweed ice front and draining over a col at Neidpath. The cover of till over the clays (which are believed to be lacustrine in origin) demands the extension of the ice at this or a later period over the whole area if it is in situ. Erosion of the col, in association with deposition in the old channel must have been such as to render the former course impossible on deglacierisation. In 1961, Price suggested the gorge may owe its present form largely to subglacial erosion by meltwaters.

The present Tweed water level in the Neidpath area is approximately 530 feet O.D.; the southwest to northeast ridge, commencing near Crosshouses (220 384),which separates this river from the Manor Water, varies in height between 640 and 680 feet. The evidence quoted above shows that rockhead in the Cademuir channel is below 655 feet O.D. at the west end (2179 3671) and possibly below 545 feet at 2525 3779. Two viable explanations exist for the considerable variations in rock surface altitude: both may be correct in part. The first of these is that the dry channel contains very thick deposits, of the order of 130 feet or more, and, along with this, that a buried channel plugged with drift may occur in the southwest to northeast ridge, representing the old channel of the Tweed. Alternatively, it is possible that glacial erosion, particularly in the Tweed Valley, as propounded by Goodchild (1902),has grossly modified the rockhead topography since the Tweed last flowed through the

Cademuir channel.

Several other less massive drainage changes were noted in the Lower Tweed area by Somervail (1918). Among his suggestions were that the Tweed once flowed through the dry channel on the south side of Wark Kaim (820 387) and that the Whiteadder once ran in the now-dry valley from 730 598 to 765 580, rather than in the present route via Abbey St. Bathams. He also 'suspected' that the Bowmont once flowed north-northeastward past The Haggs (861 354) to join the Tweed direct instead of flowing southeastwards to merge with the College Burn. This he based on sections in sand and gravel at 859 355 which he believed to be blocking the former course. From morphological evidence, he inferred that in preglacial times the Kale Water flowed eastwards rather than westwards from Morebattle, joining the Bowmont near Town Yetholm (822 285), rather than the Teviot as at present.

Both Butler (1904) and Clapperton (1967) accepted that a former course of the Till lay along the Crookham to Cornhill depression. Common (1953) postulated that the trough of low ground between Cheswick (032 466), Beal, Felkington and Norham (900 474), opening onto coastal low-lying alluvium, may have been the line used by the Tweed in 'preglacial' times. A previously unrecorded dry valley of substantial size, partly infilled with till and fluvioglacial deposits occurs between Sprouston Station (759 353) and 790 370. It must be concluded that on morphological evidence alone that numerous changes in drainage orientation have occurred in late Pleistocene times in the Tweed Basin but until better evidence, primarily in the form of borehole control or the provision of sections, is available, the possible increase in knowledge of their origins and subsequent history is limited.

CHAPTER 5

TERRACE FRAGMENTS AND RELATED FLUVIOGLACIAL FEATURES BETWEEN BERWICK AND FLEURS CASTLE.

For convenience of description of the local and regional variations in distribution and form of the terrace fragments within the field area, three major sub-areas have been delineated. The first of these covers a strip adjacent to both banks of the Tweed, extending from the mouth of the river as far upstream as Fleurs Castle (711 347), near Kelso. This has been further subdivided into three smaller sections, while in a fourth the evidence for a buried valley of the Tweed in this area is considered. Normally terrace fragments are described in an upstream progression throughout each section.

A. The Berwick to Coldstream area. (Figures 5.1 and 5.2)

Clear ice-contact forms are rare in the lower Tweed Valley, the only known examples of any significance inside the field area proper being the kames between Mount Pleasant (953 509) and East Loanend (945 507), believed to be such from their morphology; a section at 9475 5065 showed 3 feet of bedded sand overlying coarse gravel of unknown depth. Milne Home (1875 p.538) recorded 30 feet of sand being found in one borehole near this point which did not reach bedrock. A small sinuous ridge at 953 498 is probably an esker. To the southeast side of the northeast - trending ridge on which this esker lies, a large meltwater channel, commencing near 955 490, runs for approximately 2.5 miles northeastwards to East Ord and Tweedmouth. Clapperton (1967 p. 236) suggested this had been cut by waters originating from the Till gorge, presumably initiated in a subglacial or an ice-marginal position.

Small kames were also mapped at 894 450 and at 868 420, where gravel and sand some 3 to 4 feet thick were seen to be overlain by 2.5 feet of silty sand.

The only fluvioglacial features known to be associated, in this area, with terrace fragments are the kames near Mount Pleasant although F 840 on the opposite side of the river, steeply inclined from front to back, is fed by a substantial dry channel commencing above 160 feet O.D. Similarly, a northwest-trending dry channel feeds the large flat at just over 100 feet O.D. above Norham Boathouse (895 465). At Mount Pleasant, however, the kames are succeeded downvalley by fragments 863, 865 and 867. These are rather irregular in morphology, being slightly domed in the centre and the most likely explanation of their origin, bearing in mind the lack of sections, is that they are ice-moulded ridges, the crests of which have been eroded by meltwaters and the intervening depressions largely filled with outwash.

The existence of supposed river terrace fragments in this area was noted by Fowler (1926 p.34), who stated that at Yarrow Slake, three such features were visible, the highest 50 feet above the river. Between Horncliffe and Norham he observed two terraces ,the higher being about 40 feet above the river while at the latter spot "numerous gravel spreads" were said to occur up to 50 feet above the same datum. The relict fluvial nature of Groat Haugh, mapped in this study as F 793, was suggested as long ago as 1895 by Gunn. Later Pringle (1948 p.83), in a generalised and relatively inaccurate account, grouped Lower Tweed terraces into those 60 - 80 feet above the river, those 20 - 50 above the same level and others, equating these groups with the now discredit -ed 100, 50 and 25 feet raised beach sequence. Sissons (1967a p.117) invoked a different model of terrace evolution in stating "Along its lower course from Berwick to beyond Kelso the river is bordered by an almost continuous belt of fluvioglacial deposits that forms numerous terraces close to the river itself. A given terrace may be traced upstream from the level of the floodplain to a height of 30 to 50 feet above the river before it dies out. Meanwhile another terrace has often appeared at a lower level and this may in turn be followed in a similar manner."

Unhappily, the sequence is more complex than suggested by any of these authors. Only in one case in the Lower Whiteadder valley, for example, is the 'en echelon' arrangement of fragments known to be obvious: in general the relationship between higher and lower terraces is often much more subtle than can be brought out by field mapping alone. In many ways, this area contains the most difficult of all geomorphological problems in the Tweed Valley. Wide expanses of flat or gently undulating topography, constituting high level flats[1], are ubiquitous as far upvalley as Ladykirk (888 476) and

1 The term high level flat is used in a general context to denote remnants at least 60 feet or more above the present river at any one point. Likewise, the expression 'n feet above the river' should not be taken to imply that the fragment is parallel or sub-parallel to the latter. Rather it is a deliberately vague statement, intend-ed to be accurate only to ± 5 feet and therefore presents consider-able possible variations in terrace fragment gradient as even the largest remnants rarely exceed 0.5 mile in length.

spasmodically thereafter until Coldstream. Included in this category are fragments 716, 718, 755, 769, 781, 794, 796, 815, 825, 827, 835, 837, and 845. It was found impossible to map many others because of substantial height variations over low angle slopes with no marked discontinuities. Of the examples quoted the flattest and possibly the largest is F 794 in the area of Winfield aerodrome which succeeds drumlinised drift and drumlins proper in a downvalley direction. This flat is apparently continued from about Nabdean (925 523) downvalley to Gainslawhill (953 526) by fragments 796 and 798.

Milne Home (1875 p.539) described a section along the river from Union Bridge (935 511) to 959 522, underlying this large surface and consisting of up to 90 feet of sand and gravel overlying irregular rockhead topography. Today no good sections are exposed in the area, that in a gravel pit at 9390 5226 showing 15 feet of stoney clay overlying 10 feet of fine sand, the junction between them being transitional over a vertical distance of about 9 inches. Rock was exposed under the sands. In a very poor section some 300 yards to the east, 20 feet of stoney clay appears to overlie approximately 4 feet of fine sand which in turn overlies more clay. The former existence of Paxton tile works on the edge of this flat suggests that a non-stoney source of clay was available. Virtually the only other section known under these high level flats is at 928 517 where 10 feet of drift, much obscured by clayey surface wash and slumping, overlies bedrock in a gulley. The equivalent depth of drift in a similar gulley cut into F 859 on the other side of the river is approximately 20 feet. Augering through F 794, 796 and 798 generally revealed at least 3 feet of clay or sandy clay consituting the uppermost terrasiform deposits.

Thus it is far from clear from available evidence if all or any part of these deposits is glacial outwash or till. The numerous rounded stones littering much of the ground surface (except where cleared by farmers), often up to 1.5 feet but normally between 2 and 4 inches long, are potentially misleading; it has already been pointed out that many of the till sections in the Tweed basin include such stones. It may be, however, that two or more different origins account for these flats, as in a section underlying an unnumbered terrace remnant some 200 yards east of Lennel Church Yard, the follow-ing succession was noted, with quite sharp junctions between adjacent layers:

Ground surface

1 foot soil profile

1.5 feet large boulders, up to 1 foot diameter

2 feet gravel, up to 1 inch diameter

2.5 feet coarse sand, with indistinct near-horizontal bedding

1 foot gravel, up to 0.5 inch diameter

8 feet fine, medium sands and silts, interbedded and slightly contorted

Micaceous sandstone

The fine sands include interdigitations of rounded gravel up to 2 inches diameter. Thus here there is no evidence of till and these deposits are provisionally interpreted as ice-distant glacial outwash. Haldane (1948 p.16) noted the existence of pits showing small gravel underlying F 726, a similar high level fragment at Milne Graden.

Even where the problematical higher flats do not occur adjacent to the river, some difficulty was often found in mapping the vertical gradation from obvious terrace fragments at lower to drumlins at higher levels, owing to the low angle slopes and flat crests often associated with the latter. This was particularly a problem in the grounds of Ladykirk House where the relatively narrow fragments 742 and 740 may indeed be ice-moulded ridges, modified by meltwaters and subsequent slopewash to flatten their cross profiles. The same difficulty was experienced in the area between the river and St. Cuthberts (871 425) and in a similar tract between the river and Norham West Mains (916 481). In both of these locations the subdued forms of what are possibly ice-moulded ridges, compared with the much sharper forms higher up the slope confirm the plausibility of meltwater modification of their original form. In general, this problem was met wherever the orientat-ed relief parallels the present course of the river. Where the valley meanders across the grain of the relief, as at 890 465, much less ambiguity of interpretation is possible.

The most striking and yet puzzling example of a flat-topped ridge paralleling the present valley occurs southwest of Berwick where fragments 871, 877, 879 and 881 constitute parts of what may be one feature. The flat top of the ridge extends over too wide an area to be due entirely to human interference. In contrast to the local eastward trend of the relief, this feature trends northeastwards and is also noteworthy because the tile works at Mill Farm (Chapter 4) extracted stoneless clays, laminated in part, from the northwest extremity. The triangular area contained between this ridge, the east-trending relief immediately to the south and the river, on which flat most of Tweedmouth is built, is also of considerable interest. A small channel with a marked up and down long profile breaches the ridge at 985 522 while another formerly drained the lower-lying tri-angular area to the east through Ladywell housing estate but has now been partly infilled. Boreholes for a Heavy Vehicle Testing Station around 989 525 showed black peaty material at some 11 feet from the surface, this being overlain and underlain by red-brown clay. It is likely that this organic material represents the surface vegetation before contractors carried out earth moving operations some ten years ago. A bore at 9881 5192, almost certainly through undisturbed ground, showed 20 feet of till.

Very much clearer intermediate level terrace fragments were found in several parts of the Lower Tweed Valley. In many places the gorge-like nature of the valley precluded anything other than the ubiquitous near-river remnants, possibly present-day floodplains, but on the insides of meanders, such as at Ladykirk House and below Norham West Mains, well marked features were found. The greatest number and complexity of these occurred at river junctions. Three certain and one possible (F 769) fragments were mapped on the south side of the Till - Tweed junction while at Cantys Bridge (957 526) the best preserved inter-mediate height fragment in the Lower Tweed Valley emanates from the mouth of the Whiteadder, apparently cut into the high level F 798, and may be continued down the Tweed valley as the extensive F 818. Two hollows on the surface of this remnant, built up against a truncated drumlin (974 525), may be shallow kettle holes, appearing to lack outlets,but equally may be largely-infilled stream courses. Cut into or banked up against the frontal scarp of F 818 are F 822 and 824, the long profiles of which, from mapping evidence appear to be 'en echelon'. Fragment 824, which has a very stoney surface, appears to pass below the widely developed but near-stoneless F 826.

Right bank intermediate level terrace remnants, equally well defined, exist slightly farther up-Tweed (F 847 and 849). The former fragment bifurcates around a north-south orientated ridge at 945 517, being continued to the south by F 855. This ridge, perhaps a knoll of bedrock is also surrounded by two channels, both lower than F 847 or 855, the western one relict and the eastern occupied by a small stream. Fragment 831, some 40 feet above the present Tweed, has a marked backslope in cross profile and is irregular in some parts, particularly around 917 495, where erosion has removed much of the front.

The sub-surface constitution of these fragments is largely unknown. Only in a gravel pit at 8725 4342 is there a good section in such terrasiform deposits, in this case underlying F 783 (Plate 8). Here the exposed section was:

3 - 4 feet unbedded silt and pebbles with a few boulders up to 1.5 feet diameter.

Sharp junction.

12 feet horizontally bedded rounded stones up to 2 - 3 inches diameter in a sandy matrix with some boulders up to 15 inches diameter.

As the section is not directly under the terrace fragment but rather is under the slip-off slope leading down from it, the silt overlying the gravel may be the result of hillwash and creep, especially as the bedding on the much steeper western face of the pit is truncated parallel to the surface slope by similar material. The section may represent not the terrasiform deposits underlying F 783 as believed when originally mapped, but rather an upstream projection of the deposits under the lower F 785, partly covered by wash from the higher terrace fragment.

Much thinner drift is known under parts of similar terrace fragments.

At 8850 4555, under the upstream end of F 738, the following sequence was observed:

2 - 3 feet gravel up to 1 inch diameter

1.5 feet gravel up to 8 inches diameter

3 feet silty clay with occasional stones

Bedrock

No available sections were suitable to permit any relationship between the rounded stones common on medium and higher level terrace fragments and the nature of the terrasiform deposits to be observed.

Lower terraces and terrace remnants are ubiquitous throughout the Tweed Valley but, although easy to demarcate in mapping, defy any correlation by simple inspection in the field of their height or the underlying stratigraphy. Commonly the latter is exposed in river banks but almost invariably consists of fairly homogeneous silty sand with faint traces of bedding and occasional gravel lenses. Variations in fragment height may represent the dissection of one backsloping fragment by scour routes or the result of distinct but vertically close stages of river downcutting.

The degree of dissection of the terrace fragments differs appreciably in scale and kind. Many of the high and some of the medium level flats are trenched by deeply incised tributary valleys, common along this section of the main valley and invariably extending to the present river surface. The most spectacular of these incised tributary valleys are that of the Till, cut 70 feet or more into rock at 885 434, and the 100 feet deep, steep-sided, now almost-dry valley terminating some 150 yards south of Norham Boathouse. The latter is especially remarkable for the extreme rate at which it becomes incised, attaining a depth similar to that at its termination after only 250 yards from its source near East Newbiggin and then flowing to the Tweed in a zigzag course dictated in part by the lowest path between drumlinised relief. There is a general absence of terrace fragments within this tributary valley but, in contrast with this, the Till Valley contains several remnants near its junction with that of the Tweed.

Few medium level terrace fragments are large enough to permit the tracing of relict channel patterns. Even large examples seem devoid of such features except in marginal areas, suggesting surface resorting and post-formational infill of channels. Lower fragments are frequently modified by dry channels (e.g. F 806 and 708) and in some cases these may virtually obliterate the original form. An exaple of this is afforded by F 833, under Horncliffe village, where a channel scars the fragment at its upstream end and a fan impinges on the downstream extremity.

B. The Cornhill to Wark Area. (Figures 52 and 53)

Few sections of the Tweed Valley have been discussed in so much detail as that containing the sand and gravel deposits that extend eastwards from Cornhill to Crookham. Much of the early literature, including that by Stevenson (1864 and 1874), Mearns (1865), Milne Home (1875), Gunn (1895 and 1897), Goodchild (1898), Gregory (1922, 1926a), Fowler (1926) and Carruthers (1932) described and discussed these sands and gravels or adjacent similar features in varying degrees of detail. It seems likely that Anderson (1939 p.320) referred to one of the parts of this system when he stated that "a mound of sand and gravel one mile south of Coldstream is flat topped at that level" (140 feet O.D.). Recently, both Laws (1966) and Clapperton (1967) have added to the knowledge of the form and origin of these deposits. Although most of the system lies outside the present field area, these deposits must be considered as they could be of considerable significance in relation to the high level terrace sequence in the Coldstream to Berwick area.

The best early description of the morphology and structure of the features was given by Gunn (1895 p.76), who stated that the western boundary of the sand and gravel "seems everywhere to occupy lower ground than does the boulder clay adjacent" while the other drumlins are typified by Blake Law which "rises like an island of clay out of the billowy sea of gravel." He described the latter deposits as consisting of "layers of sand and gravel (which) are ....twisted or contorted as if formed by an eddy." (p.74). In the main, the deposits appear to be composed of dirty sands and gravels, often highly contorted and occasionally including seams of clay. Clapperton (1967 p.230), in describing the system in some detail, said that: "ice contact slopes bounding the ridges and terraces are everywhere steep and freshly preserved. The majority of the ridges are massive, the.......crests standing frequently 60 to 120 feet above adjacent depressions....... extensive terraces (exist) pitted with kettle holes and fringed by crenulate ice contact slopes...... In some places, terraces are connect -ed by narrow ridges." The depth of peat infill in and size of the kettle holes can be judged from the complete entombment of a railway engine in one after a derailment during the construction of the Berwick to Kelso railway.

While Gunn did not venture an opinion on the origin of these spectacular features, Carruthers (1932 p.130) entertained few doubts on this question. He viewed the deposits as a kame moraine, formed of water-sorted sands and gravels washed onto the surface of the Tweed ice margin. These sediments and the water transporting them were supposed to have originated in the Glen/Bowmont Valley, which he postulated to be largely ice-free at that time. Clapperton (1967 p.232) has criticised this interpretation on two grounds:

"1). If the Bowmont/Glen valley was sufficiently free of glacier ice to allow the transport of large quantities of sand and gravel from the northern flank of the Cheviots, it is more likely that this would have been confined to the pre-existing valley of that stream rather than be transported over the watershed and onto the Tweed glacier lying some distance to the north.

"2). Detailed mapping of the sand and gravel deposits illustrates that they are arranged in long, prominent ridges or terraces, clearly aligned either from west to east or from southwest to northeast."

Clapperton proposed an alternative model of the evolution of the system which is illustrated in figure 5.4. Initially, it was suggested, the water depositing the sands and gravels flowed eastwards, turning northeastwards at the east bank of the present course of the river Till, as indicated by the alignment of several eskers, and entered the large Haydon Dean meltwater channel near Duddo. This channel, cutting through the west-facing escarpment of Fell Sandstone, is believed by Clapperton to have been initiated subglacially but to have become a proglacial feature while still in active use. The two inlets are at approximately 225 feet and 200 feet O.D. - figures identical with the heights of the two highest sets of kame terraces in the Crookham area.

A second and lower stage is represented by kame terraces of altit-udes between 150 and 175 feet in this same area. There is no breach in the escarpment as low as this so, in conjunction with the eastward cessation of the sands and gravels at the upstream end of the Till gorge and the lip of this gorge being at an altitude of 150 feet O.D., Clapperton postulated that at this stage the water drained, subglacially perhaps at first, down the present course of the Till, cutting a substantial gorge in bedrock. He claimed that "much of the meltwater drainage from the mid-Tweed area (including the Ettrick, Yarrow, Gala and Leader Waters) possibly entered the depression between Cornhill and Etal; the route to the sea presently occupied by the lower Tweed was probably formed much later." (p.309).

Intervening between these two stages, a glacially-dammed lake formed in the Till basin in which at least 70 feet of lacustrine clays accumulated in one part. These sediments, in what Butler (1904) termed Lake Ewart, are overlain by an outwash delta, the largest part of which is believed to be approximately contemporaneous with second stage.

Despite this being the best interpretation on the evidence available, several anomalies persist. One of these is the non-existence of stagnant ice phenomena in much of the Till Basin although well preserved between Cornhill and Crookham in the west and around Hedgeley in the east. This led Carruthers (1932) to postulate that all the intervening material had been swept away by the rivers Till and Glen. Sissons (1965 p.477, 1967a p.130) has suggested an alternative explanation by implication, that the western deposits may be related to the marginal zone of the Aberdeen - Lammermuir Readvance.

A minor modification to the Clapperton model may be necessary in view of the evidence which exists for a late stage water flow to the west, compared with the continuously eastward flow that he envisaged. Meltwater channels such as that merging with or going under F 721 at 853 380,which is incised into the sands and gravels by about 30 - 4o feet in its lower course, suggest this westward flow and also perhaps that at both early and late stages water originated not only from the present Tweed valley but also from the Upper Bowmont. Further evidence to support this includes a gravel pit at Cleghorns Knowe (8618 3711), which showed the following section, with the bedding dipping at 10 degrees to the eastnortheast:

4 feet of sand with small gravel

30 feet of fine to medium sand, often forming ripple-marked horizons

Two other channels in the same area commence by running towards the northeast and then swing northwestwards, merging to form the large channel described above.

It is possible to trace this belt of kames, kettles and kame terraces farther to the west than previously noted. The flat-topped sand and gravel mound labelled F 737 at 8560 3924 in Cornhill and a small east-west oriented gravel ridge commencing 150 yards to the west of this, just poking through the surface of F 739, are outliers of the much larger system. Similarly, the sinuous ridge forming the northern boundary of F 739, itself bounded on the north by a kettle hole and sands and gravels of amorphous morphology, is believed to be an esker, continuing the overall east to west trend of the system and being truncated by the present river. An up and down channel bisects the ridge, draining southward away from the kettle hole. Numerous stones, some up to 1.5 feet in diameter, litter the esker surface; one was found to be markedly striated.

West of the river, at 8467 4007, a section between 82 and 88 feet O.D. and some 20 feet below the ground surface revealed bedded sands and fine gravel up to 1 inch diameter, the latter in lenses. The bedding was often contorted and quite frequently faulted (Plate 10). Similar lithologies were noted at higher levels some 200 yards to the east. In contrast with this, an exposure at 8320 3915 showed 20 feet of fine to coarse gravel, up to 12 inches diameter with only occasional thin lenses of sand, overlain by up to 10 feet of silt with incorporated gravel. Only over small areas at these altitudes is the surface morphology flat enough to merit the term 'terrace fragment.' According to Haldane (1948 p.16), Coldstream itself is situated in the midst of an extensive area of mounds and ridges of fluvioglacial material, and also of river terraces. In recent years building has obscured much of these.

Two miles to the west of the Cornhill sands and gravels and apparently entirely separate from them except for a 300 yard long sinuous ridge at Learmouth Siding (848 380) and another (largely buried) at 827 383, is the Wark Kaim (Plate 13). The term kaim, used in the old Scottish sense as a mound, either conical or sinuous and usually earthen although occasionally of rock, was used at an early date to describe fluvioglacial features in this part of the Tweed Valley, the most notable examples being that at Wark and another at Bedshiels (Goodchild 1898). The former is approximately 1,000 yards long and up to 50 feet high, modified in its centre by the ruins of Wark Castle. In the main, it is a sharp crested ridge, steeper on its south side where it overlooks a dry valley. At both up-and downstream ends it is composed of two parallel ridges which, in the former location, have flattened by farming and road-making
been made flat-topped for agricultural purposes and ease of road-building, while the village of Wark lies athwart the lower of the two ridges.

Mearns (1865) described a section at Wark (835 387), now long over-grown, as consisting of 24 feet of bedded sands and gravels in layers of varying coarseness, dipping outwards from the centre of the ridge. A lens of clay, 60 feet long and over a foot deep, containing one large and no small boulders, also occurred in the section. A new exposure, visible for a few weeks in 1966, is reproduced as section 19 in appendix 6.

The earliest known non-mythical interpretation of the origin of this feature was provided by Stevenson (1864) who suggested it to be a marine spit. Mearns (1865) conclusion was that it was formed by currents in a former sea, a view with which Milne Home (1875) readily accorded. Goodchild (1898), in dealing primarily with the morphological -ly similar but longer Bedshiels Kaim, decided this was a glacial feature and probably represented a crevasse filling. Gunn (1895) and Gregory (1922) looked upon the Wark kaim as an erosional remnant, part of a sheet of sand and gravel formerly contiguous with that in the Cornhill area. In view of the section described by Mearns which showed bedding sub-parallel to the sides of the Kaim and modern knowledge of such forms, it is impossible to avoid the conclusion that this is a large esker.

The relationship of the terraces and terrace fragments in this area to the ice-contact fluvioglacial landforms can be summarised as follows. Virtually all of the low terrace remnants, such as F 743, 749 and 751 are clearly unrelated to these systems. A typical section in deposits underlying such a low terrace (F 721) at 8545 3913 consisted of 10 feet of silt, overlying 1 foot of rounded coarse gravel above the surface of the Tweed. Surface disfigurement by dry channels is common, as on F 692 and 694. The former course of the Leet Water, joining the Tweed at 8425 3900, is represented by an 8 - 9 feet deep dry channel and is presumably fairly recent. These surface irregularities are rare on terraces only 10 feet above the lowest flats, which suggests these flats are divorced from the erosional effects of the largest floods known at present, such as those of 1831 and 1948. An examination of maps on a scale of 1/25,000 of areas inundated on the latter occasion (pers. comm. G.S. Easton) revealed that only the lowest of terraces were covered by flood waters at this time. Due to the upward increase in valley width, however, the increases in altitude of the river surface by amounts such as 9.5 feet at Fleurs Castle represent very considerable increases in discharge.

In common with the low terraces the intermediate level terrace fragments (there being virtually no high remnants in this broad section of the Tweed Valley) do not appear to be intimately related to the fluvioglacial features. The relationship, however, is much more complex than that between the ice-contact features and the low terraces. In several locations, it appears that these intermediate level flats bury kames and other fluvioglacial features. At 827 383 and 854 393 ridges of sand and gravel are almost wholly buried beneath terraces, while the fragment F 687 appears to run into the dry channel south of the Wark Kaim and emerges as F 719. The extent of this latter remnant, spreading around both sides of the downstream end of the Kaim suggests a once-complete enclosure, while the form of the esker suggests that this fragment may mark the post-glacial 'Fluvial limit' in this area.

On a local scale the effects of human agencies in making or modifying terrace fragments can not be dismissed. It became apparent that detailed mapping in urban areas is fraught with hazards where no sections are available; even small scale contracting work and landscaping can significantly alter the surface morphology, usually tending to increase the number of terrace remnants. Known modifications in this area include the existence of a now-disused graveyard north of the Wark Kaim (Mearns 1865) and the removal of the crest of a kame near Cornhill as ballast for a railway embankment in the mid-nineteenth century.

C. The Wark to Fleurs Castle Area.

The change in valley cross profile from a narrow incised form below Cornhill to a broad , dished form above the village for 15 miles upstream results in the continuation of the basic pattern of many low and medium level terraces,already established in the Wark to Cornhill area,as far upvalley as Fleurs Castle and Tweedbank. As a further result, ice-moulded forms are frequently visible quite close to river level, as at 770 384 where the downstream end of a drumlin disappears below terrasiform deposits only some 25 feet above the river.

Several eskers exist in this area, the most notable of which is that commencing at Home Farm (7066 3505) and running northeastwards for 1.5 miles although Haldane (1948 p.15) claimed that it re-commenced at Hassington (737 414). Another, 300 yard-long esker parallels the upstream section of that at Home Farm. For much of their length, these eskers run along the hollows between ice-moulded ridges, probably drumlins. This complete concordance with the underlying topography suggests they were formed at a late stage in the local deglacierisation, when the ice in this area was very thin indeed. Many of the hollows between drumlins are partly infilled, probably in part by final stage fluvioglacial deposits. Kame and kettle complexes were found in three main areas adjacent to the Tweed. The first and most interesting of these is in an area to the south of Reddon (776 375). Here a dry valley (Chapter 4) contains ridges, mounds and closed depressions; although no sections are now visible, the surface of most of this area is littered with rounded gravel up to 4 inches diameter. These features occur at both up-and downstream ends of a large high flat, F 679, measuring some 500 yards across by 1100 yards long. The ridges, below the level of the latter surface, are arranged transversely to the downvalley direction. Other kames , a 600 yard-long esker and what appears to be an isolated terrace fragment with a very steep backslope also exist within the dry valley. Bedrock is exposed in several spots on the south side of this valley (7960 3725, 7890 3685, etc.) and it seems that here the drift cover is thin. The exit of this dry valley, now blocked by kames, probably re-enters the present Tweed at Wiel Plantation (790 378). Blocking may be partially accomplished by till as exposures of this were seen in small stream sections. A larger section of grey-blue till was recently exposed in a landslip a short distance away at 7970 3816.

With the exception of F 679, all the terrace fragments mapped in the vicinity of the dry valley seem to postdate any major water flow therein. The remnant F 649, for example, sweeps around the entrance in a dogleg form in plan, apparently ignoring it although within a few feet (vertically) of the rim. Traces of higher flats, such as F 651, were noted adjacent to the disused railway and these may be related to water flowing through the valley.

The large fragment 679 is unique in the Tweed valley: bounded at both ends by transverse lower ridges, to the south by a wide, partly infilled dry valley and to the north by a steep slope to much lower terraces and the river, it is completely isolated from higher ground, standing plateau - like in the middle of the valley. A kame and a kettle hole exist half way down the steep northern slope, followed downvalley by a narrow terrace fragment, F 675. The surface itself is creased by two dry valleys trending, like the plateau long axis, east-northeastwards, except that one swings northwards for a short distance at 778 370.

No sections are exposed around the flat. For this reason a series of seismic traverses was made parallel to the Reddon - Gateside road, commencing at 7791 3697 and terminating at 7774 3725. The results are tabulated as sets 53 to 56 in appendix 4 and the interpretation is portrayed in figure 5.5. This suggests a surprisingly thin drift cover, possibly of very loose sand overlying the local bedrock (Calcifer -ous Sandstone), and varying between 4 and 10 feet in depth. In the north, where the drift was thickest, a layer of wet gravel was also infered from the results. The velocity values for the lowest layer of 7 - 8600 feet per second are slightly low for sandstone in this area, but the marked velocity breaks at the seismically significant surfaces and the low degree of scatter of points about the best-fit line, with no discontinuities, suggest no significant lateral variation in sediment density and that some confidence can be placed in the interpretat -ions. Augering at 7790 3700 revealed 4 feet of loose sand with a little sandy clay, entirely consistent with the interpretation of seismic evidence. Bedrock was not reached at this depth.

The only other flat at all comparable with F 679 is that on which Fleurs Castle itself is built, possibly continuing eastwards above Angroflat Plantation, although flat-topped ridges, such as that on which Birgham is built, are not infrequent. Milne Home (1875) long ago pointed out the Fleurs flat but it was not possible to survey this owing to official restrictions. No major morphological discontinuities were noted, including a complete absence of any kettle holes. Nonetheless, this may represent glacial outwash deposited between the ice-moulded ridges to the northwest and southeast although the possibility of substantial human interference, in view of the scale of the castle, can not be ruled out.

The second mass of kames and kettles found adjacent to the river between Wark and Fleurs Castle is relatively small and is centred on 760 380 in the Eden Water tributary valley, some 800 yards from its junction with the Tweed. Here the kames are conical in form and as is common on such features, the surface is littered with gravel and boulders up to 2 feet in diameter. Although well above and therefore probably unrelated to F 648, fragment 650 is banked up against the northern faces of these kames and is pierced by a kettle hole. The rim of this remnant is about 6 feet above the floor of a dry valley which subsequently merges downvalley with F 648. The Eden Water valley apparently functioned as an important meltwater channel at one stage in the deglacierisation (Clapperton 1968)

A third and the last known kame complex occurs in the mouth of the Teviot Valley, ending 500 yards up-valley from where it merges with the Tweed. Clapperton (1967 p.308) said that kames, kettle holes and kame terraces parallel the river down to the junction but in the small area of the lower Teviot that was mapped, no proof exists that the fragments are kamiform in nature. Small sections revealing a few inches of sand and gravel are common in these features. The ridge on which Roxburgh Castle is built, dividing the Teviot from the Tweed, has manifestly been altered by human interference. The overall form approximates to that of a large esker but it may be that this is simply due to erosion by both rivers of a continuation of the "good sands with some gravels" to the southwest and south noted by Haldane (1948 p.13). It seems to be unrelated to any terrace fragment.

Across the main valley from this kame and kettle complex and apparently at closely comparable altitudes are the largest intermediate level terraces in the whole Tweed Valley. These commence on the left bank of the river at the upstream end of the Fleurs Castle estate, reach -ing a maximal width of 400 yards, while similar if narrower features exist on the other bank of the river some 600 yards upstream from the Teviot-Tweed junction around 715 340. The longest continuous entity, F 582, runs for at least 1.5 miles and possibly rather more if it is continued as the marked feature mapped throughout the higher parts of Kelso. Similar features re-appear between Hendersyde Park and Springhall on the north bank and Mellendean Bridge (7415 3447) and Sprouston on the south bank. The flat-topped ridge, F 643, is probably a residual of F 639, dissected by water originating from the south-southwest.

Other comparable fragments were found to continue spasmodically eastwards as far as Coldstream, terminating in the terrace which appears to run continuously from Carham Church, south of the Wark Kaim to end at 8345 3840 as F 719, following part of the course of what Somervail (1918) referred to as'the Dry Tweed'. In general the continuity and size of similar features on the northern bank is less marked downvalley from Springhall but F 644, 654 and 672 are comparable with F 649, 665 and 687 in extent and state of preservation.

The occurrence of obvious now-dry channels on back-sloping lower terrace fragments such as F 596, largely missing from the higher fragments like F 582, again made it difficult to decide how many discrete lower stages were present in any one small area. Apart from the cases already noted, there appears to be no close relationship in this area between ice-contact features and terraces. Only fragment 650 was definitely scarred by a kettle hole.

While riverside sections under the lowest terraces showing 5 to 6 feet of well sorted silty sand with occasional gravel lenses are quite common, sections are rare in the higher terrasiform deposits. The Teviot river bank at Kelsohaugh, 7185 3370, provided a section in the deposits underlying F 607 (Plate 15). This was made up of 2 to 4 feet of colour banded silts, chiefly yellow and brown and slightly contorted, overlying and interdigitated with the top layers of 5 to 8 feet of coarse gravel. The minor contortions are probably primary depositional features as in most cases they reflect the morphology of the gravel surface as seen in cross section. Such a section casts some doubts on the significance of a terrace fragment as this deposition of silt may be very local, due to perhaps deposition from the Teviot when flowing into the Tweed at a time of flood, such as occurred in 1831 (Milne Home 1875) and in 1948 (Learmonth 1950). Where the main valley is broad, as at this spot, flood levels of up to 10 feet or more above present have been recorded. At such times the valley floor becomes a shallow lake, moving relatively slowly at the margins, permitting near-still water deposition at tributary junctions. The possible effects of variations of discharge of the Teviot at these times are unknown as flood records are much more scarce for the tributaries than the Tweed itself. Some indication of considerable variations in river stage, however, is provided by Milne Home's (1839) account of the drying up of the middle and upper reaches of the Teviot and Ettrick in 1838. In the absence of other sections in the area, it is impossible to demarcate the extent of the banded silts.

A section at 7561 3609 under F 649, some 600 yards northwest of Sprouston, showed only 1 to 5 feet of drift, mainly sand and gravel, overlying the bedrock which at this location consists of basaltic lavas.

Only a few yards away, however, other sections showed much thicker drift under the same fragment and thus the surface seems to be markedly unaffected by gross variations in sub-surface lithology.

Although several wells pierce the Fleurs terraces, no records other than 'drift over rock' exist. To obtain more information on the deposits underlying these extensive features, a series of seismic traverses was made along a cross section stretching from 7080 3425 to 7124 3399. The results are tabulated as sets 45 to 52 in appendix 4 while the interpretations are illustrated in figure 5.6. Of the 8 traverses carried out on these fragments, only one set of results yielded discontinuities in the graphs, on F 598. All other graphs are simple in form, showing a small degree of scatter of points about the 'best-fit' lines. Thus it is deduced that the underlying material is unlikely to include till and that there are few substantial lateral variations in sediment density. The provisional nature of the results, however, must again be stressed as they are not tied directly to borehole control.

The evidence suggests that under the two lower terrace fragments, F 596 and 598, rock parallels the ground surface at a depth of between 15 and 17 feet. Examination of riverbank sections tended to confirm the interpretation of wave velocities, that this drift consists of dry sand and gravel. There is some evidence, although this is based largely on one point, of the presence of a buried valley under F 582, the lowest known point of which is similar in altitude to that of the present Tweed surface. The wave velocities suggest that this valley, close to the relatively impervious till, is largely infilled with saturated sands and gravels. It is impossible to be certain whether the second layer in sets 49 and 50 is sandstone or a very compact till as the mean velocity of 7,550 feet per second falls in a possible overlap zone between these two materials. Another interface was located between 38 and 44 feet below the surface and it may be that this is the true bedrock surface underlying till. Alternatively, this may be due to a layer of the basaltic Kelso Traps, interdigitating with the Cementstone group in this area, an interpretation favoured by the high mean velocity for this layer of 16,500 feet per second.

The paucity of good sections or boreholes in terrasiform deposits in this area, as elsewhere, considerably limited much possible work. The relationship between surface texture and underlying lithology at such interesting locations as 7535 3605 could not therefore be examined. Here, on F 632, the surface is scattered with numerous rounded stones up to 3 inches in diameter. Thirty yards to the northeast, a small embayment occurs in the terrace fragment, the surface dropping by several feet and becoming devoid of stones, the texture becoming a silty loam. A possible origin of this marked change in surface texture is that at a high water stage, deposition of fines occurred, burying the large stones in the previously formed embayment but not reaching as high as the upper section of F 632. Alternatively, the lower section may have been formed at a time when frost heaving, an important agent in producing a stoney surface, was much reduced in degree in comparison with that at the previous, higher stage. It seems unlikely that this local variation in stoneyness could be due to human clearance although this certainly occurred elsewhere on haughs after the 1948 floods (Learmonth 1950).

The immediate area around the confluence of the Tweed and Teviot rivers exemplifies the problems associated with any examination of only one aspect of terraces. Here is a complex of terrace fragments, some interlocking, some clearly transgressive with respect to older features formed by the other river while the larger, lower fragments are scarred by dry channels. Under such conditions, it was found impossible to assume a 'downvalley' direction when heighting the fragments and thus heights were gathered along perpendicular traverses so that the true dip of the assumed planar surface could be calculated if necessary.

One aspect of the river channel itself remains to be commented upon: in an area where the Tweed is meandering gently with a sinuosity index of approximately 1.5 to 2.0, the 2200 yard-long extremely straight section between Edenmouth Cottage (7632 3715) and a point whose National Grid coordinates are 7765 3840 is clearly anomalous. Leopold, Wolman and Miller (1964 p.281) stated that straight sections of river channels are unusual but made the point that the line of greatest depth rarely parallels the banks. The explanation of this lineation is unknown although it should be noted that it is exactly parallel to the local direction of ice moulding.

D. Evidence for a Buried Valley of the Lower Tweed.

There is much to suggest the possibility of a buried valley under the Tweed. To the north, according to Sissons (1967a p.53), several overdeepened rock basins exist in the Forth Valley, now very largely filled with glacial, fluvioglacial and estuarine deposits. A recent site investigation for the reconstruction of Eyemouth Harbour (946 644) obtained bores which show rockhead falling rapidly westwards towards the centre of the town, reaching -20 feet O.D. at the southern end of Salt Greens Quay and certainly much lower under Main Street. To the south of the Tweed, Anson and Sharp (1960) have located deep buried equivalents of the present Coquet, Lyne and Wansbeck valleys as well as three north-

-south trending valleys, believed to be completely buried meltwater channels existing a little below present sea level. Recently, a series of bores for the Tyne Tunnel confirmed old evidence of the altitude of rockhead under the river Tyne to be at least -80 feet O.D. (Anon. 1967).

In view of the above evidence one may reasonably expect a buried channel beneath the Lower Tweed. The presence of such a feature is strongly suggested by the great difficulties encountered in piling the foundations for the Royal Tweed Bridge in 1928. It is confirmed by 7o borehole logs that have been acquired for the estuarine area.

The most detailed record available is that contained in the 1850 working plan for the Royal Border Railway Bridge. At each of the pier positions at least one borehole was sunk and the resultant section is shown in figure 5.7. The main channel is seen to exceed -60 feet in depth to rockhead and to be almost entirely filled by sand and gravel. Clay was found high on the south side of this channel between -15 and +10 feet O.D. and also in a channel cut in rockhead underlying F 889, of which there is no surface expression. The base of this latter channel is known to lie below -4 feet O.D. and may be considerably below this figure. It is possible that the clay infill is not till but is an extension of the laminated clays known some 300 yards to the southwest at Mill Farm. Seismic tests above the smaller channel showed good general agreement with the borehole logs (Appendix 4, sets 57 to 62), clearly reflecting the effects of traversing diagonally across a buried channel.

Less detailed borehole logs are available from the main road bridge site, straddling the river from 993 527 to 997 530. These were used to construct a cross section illustrated in figure 5.8. Here again the bores did not reach rockhead in the centre of the channel but demonstrate a maximal possible altitude of -58 feet O.D. for its base. Small pieces of rotten wood encountered in borehole 5 at a depth of 6 feet below the river bottom may not be significant as they could have been washed into a channel scoured in a recent flood and quickly covered by sand and gravel. It is probably significant, however, that no trace of clay was found in any of these bores.

Four unlocated boreholes taken along the line of the Old Bridge at Berwick show at least 50 feet of sand and gravel without reaching rock. Assuming the cross section of the river known 150 yards upstream at the Royal Tweed Bridge to persist, this indicates rockhead to lie below an altitude -53 to -59 feet O.D. in the centre of the channel. In no case do these bores record anything other than sand or gravel.

Further borehole evidence for the existence and delineation of the buried channel has recently become available through the growth of commercial interest in the sands and gravels of the estuarine area. C. Moffatt, a 'geotechnical consultant', has stated that eleven boreholes taken on the Shad (NU 002 523) show sand and gravel overlying blue clay of unknown thickness. As rock is exposed in a wave cut bench at present sea level a short distance to the east, it is a reasonable hypothesis that the drift cover is thickening westwards and southwestwards towards the present Tweed and the figures substantiate this, although the values are still confidential.

Four bores in the Carr Rock - Dock Road area of Spittal (NU 002 519) reached -15 feet O.D. in wet sand without touching rock. Far more valuable are those boreholes located at NU 0053 5170 and NU 0050 5189 which show, respectively, rockhead to be at about -58 and -66 feet O.D. It is probable that the deepest section of the buried channel passes between these two sites, which are separated by some 150 yards. In the shallower bore no clay whatever was found while the other found only a 5 feet thick band of clay and gravel, whose upper surface is at -48 feet O.D., over- and underlain by sand and gravel, with decayed wood fragments immediately beneath the clay. The distribution of bores in the estuarine area and the inferred route of the buried channel are illustrated in figure 5.9.

Several seismic traverses were made along Spittal beach parallel to the shore using these bores as control in what should have been near-ideal conditions for the equipment. All were very unsatisfactory due mainly to the generation of sine wave noise patterns by pounding sea waves, very similar to the normal oscilloscope traces from sand and gravel. Considerable problems were also experienced with high frequency air-coupled waves in such a bleak environment, totally lacking shelter. The presence of concrete blocks, former wartime defences, which appear to be scattered spasmodically at shallow depths below the sands, complicated the analysis of the few results obtained and limited the distance upbeach away from the noise source that it was possible to work.

Recently, analysis of seven dredged samples of sand and gravel from the estuarine area was carried out by the Institute of Geological Sciences, (Leeds) for the Ministry of Transport Engineering Laboratory (Harrison and others 1966). All the rock fragments had high sphericity and roundness indices and were of varied lithology, from greywacke to igneous material but were chiefly of a fairly hard compact sandstone. Between 35 and 91 percent of the samples by weight were coarser than a number 7 sieve, the mean value approximating to 60 percent. The clay fraction was negligible, composed mainly of non-swelling chlorite and illite.

Evidence for a buried channel and the constitution of its infill outside the estuarine area is much more scarce, being virtually restricted to the few bridge sites recently repaired. The marked incision of numerous dry valleys, many of which contain no terrasiform deposits and extend at least as low as the present Tweed surface suggests that the waters cutting these channels flowed into a major river whose surface was no higher and was probably lower than that of the present Tweed. At Norham Bridge, two bores at 8902 4728 and 8905 4728 showed approximately the same sequence of:

3 feet sandstone filling
4 - 8 feet sand and gravel
8 -10 feet gravel
5 - 9 feet decayed timber, silt, sand and stones.
grey sandstone with shale.

The deeper bore thus showed rockhead at this point to be some 27 feet below the surface of the sandstone filling, about -9 feet O.D. At Coldstream Bridge it appears that rockhead, under about 20 feet of sand and gravel, was struck at about 0 feet O.D. A bore at 8434 3962 in the lower part of Coldstream (Carter 1966 p.62) revealed some 30 feet of "alluvial gravel" over rock. The ground surface at this point is at 58 feet O.D. and thus rockhead is at 28 feet O.D., possibly on the side of the channel proven to be much lower 650 yards downstream at the bridge.

A borehole quite close to the river at Wooden Anna (7366 3409) showed 17 feet of rough gravel overlying 31.5 feet of clay, bedrock not being reached. The ground surface at this point is approximately 100 feet above Ordnance Datum. The local Planning Authority believe Kelso Bridge to be entirely founded on rock and if this is so, the possibility of any deep channel at this point is severely limited.

While not strictly relevant, recent bores at Chirnside Bridge (852 562) over the River Whiteadder show only 5 feet of sand and gravel over rock in the base of the channel,so not all major valleys in this area are heavily infilled.

Clearly, however, a channel could conceivably run either under a terrace or, if older, under the till and be unknown in the area upstream from Berwick as all the bores outside the estuarine area are concerned with the present river channel or its immediate environs. The only fully recorded bore through a terrace in the Kelso area is that at 7264 3403 (Carter 1966 p.48) which shows 27.5 feet of surface deposits, almost certainly sand and gravel in the main as this is common in holes dug throughout the town (Craig 1874), overlying rock. As the surface altitude is 122 feet O.D. at this spot on F 614,rockhead is thus at 94.5 feet O.D. The seismic traverses over the Fleurs terrace fragments, which have already been discussed,suggest a buried valley to occur beneath the highest flat, F 582, but this is of dubious proportions.

The discovery in 1964 of several stone steps leading from the Abbey at Kelso deep under the present river has suggested a fairly recent change in location of the Tweed. How much this can be taken to represent a change in altitude of the average water level at that spot is rather dubious, the drowning perhaps being attributable to lateral changes in river course, associated with provision made for periods of extremely low water.

CHAPTER 6

TERRACE FRAGMENTS AND RELATED FLUVIOGLACIAL FEATURES BETWEEN TWEEDBANK AND NEIDPATH GORGE

A. Tweedbank to Littledean Tower (Figure 6.1)

This strip of the riverine section of the Tweed Basin comprises two significantly different valley sections. The first of these is the Makerstoun Gorge, stretching for almost 2 miles upstream from Trows (690 323), near where basaltic Kelso Traps form rapids in the Tweed at 685 325.

On the south side of the gorge several exposures suggest that the drift is, in the main, relatively thin, contrasting with the area immediately downstream from Trows where numerous small kames are superimposed on a large northeast-aligned ridge, giving great variation to the depth of drift cover. Southwest of Trows, however, rock is exposed at the ground surface at 679 315 in a northeast-trending ridge, along much of the walls of the gorge and frequently in the river bottom as at The Clippers (670 313). Other exposures show rockhead here to be covered by a maximal thickness of 15 feet of clay or sand. Till is known to occur in the gorge but may not be in situ, owing to the steep slopes.

While no vestige of ice-contact fluvioglacial forms is known within the narrow section of the Makerstoun Gorge, a large, slightly sinuous ridge whose surface is composed of fine sand and some gravel exists farther downvalley, commencing at 6786 3215. In view of Clapperton's evidence (1968) that sand exists on top of some of the drumlins in this area, it may be that this ridge is essentially a drumlin, modified substantially by fluvioglacial erosion and deposition. A small esker, or complex kame which bifurcates, occurs at 669 311. Sections in the side of the gorge in this feature show it to consist of rounded and sub-angular stones in fine sand and silt, some 10 to 15 feet thick. The Law, a conical kame-like mound, has a surface made up largely of fine red sand and silt but bedrock outcrops were noted in two places. The location of the feature, opposite the mouth of a meltwater channel, may explain the presence of the sand.

The second part of this section of the valley is the funnel-shaped approach to the Makerstoun Gorge. Particularly on the north, but also on the south side ice moulding is strongly developed. At the latter location, a small but important kame complex, with intervening kettle holes modified by meltwater streams, was mapped in a 400 yard long by 300 yards wide area, stretching downvalley from 640 314. Upstream from that point, other terrace-fragments occur but are considerably dissected. On the north side of the Tweed a much-dissected higher mass of sand and gravel occurs between Dean Wood (644 320) and the 6500 easting grid line. Several small exposures revealed at least 10 to 15 feet of rounded gravel up to 6 inches diameter with some contorted bedding, underlying at least 25 feet of silt with occasional sub-angular material and rounded stones, whose size appeared to increase upwards attaining a maximal observed length of 9 inches.

The present river in this section has a low sinuosity index and all but one of the terrace fragments closely parallel the alignment of the present valley, being thin features scalloped into similar higher flats. Within the gorge only very low terrace fragments exist. Above the rim immediately southwest of The Law a flat (F581) some 150 yards long and wide occurs. Its surface, of a silty clay nature and scattered with some rounded and sub-angular stones, suggests it might be underlain by till. Fragments 576 and 578 appear to constitute the beginnings of the broad, medium-level terraces so well developed from Tweedbank downstream and already described (Chapter 5, sectionC)

The only exception to this pattern of narrow terrace fragments closely linked with the present valley trend is F571, commencing immediately downstream of the small kame complex, already described, and presumably associated with it. In some spots, this remnant partly conceals half-submerged mounds, presumably kames, as at 647 314. Elsewhere the flat is replaced by mounds with intervening hollows and it is often impossible to say whether these latter features are mainly primary or secondary.

B. Littledean Tower to Bemersyde Gorge (Figure 6.1)

This area is a convenient unit as it consists of a zone within which terrace fragments are almost entirely limited to the insides of a series of valley meanders, the outsides of which are steep incised faces, typically 60 feet or more high. Except in the two long sections of the rectangular meander around St. Boswells, the presence of orientated relief, grained towards the east-northeast in this area, appears to have had no effect on the major river or terrace orientations. Conversely, minor streams such as the Monksford Burn which are invariably deeply incised, show a marked parallelism with the local relief grain.

Till is known within these meanders as low as 5 feet above present water level (Plate 17). Quite apart from the Mertoun Mill Section described in Chapter 4, other sections noted in the vicinity of Dryburgh, particularly that at 5909 3199 in which the characteristic red till occurs some 15-20 feet above the river overlying gently-dipping sandstone, show that much of this section of the valley predates the last glaciation of this area. Kames or eskers are, on the other hand, unknown within the same stretch of valley between the flat-topped sand and gravel hummocks around 628 318 and the indistinct mounds on the flanks of the Old Melrose ridge (589 342).

The terrace fragments themselves merit little comment except that they reproduce the relationship observed in the Lower Tweed, such that the lower remnants are broader and generally scarred with channels while the higher ones, in this case up to about 50 feet above the river, are usually devoid of such features. Channels on the lower flats are often confined to the rear edge. In the main, two general terrace fragment layouts seem to exist on the insides of the meanders. In the St. Boswells meander core most of the remnants are arranged in parallel, across the end of the spur which slopes down towards the river at Mertoun Mill. In contrast with this, the Dryburgh meander core exhibits terrace remnants which are markedly askew to one another, each one cutting one, two or more higher terraces. This implies continuous shifts of river orientation, compared with shifts in lateral position but not necessarily in orientation by down-spur movement in the former. It may be, however, that this tendency is significant only in being a function of the size of the meander core and the stream involved.

Sections in terrasiform deposits are limited to the usual river-bank exposures except where sand has been dug out of the low remnant F533 at 608 314. A partly obscured, 10 feet high exposure whose base lies about 15 feet above the river was found at 6220 3173. Here a considerable mixture of particle sizes was present, the matrix chiefly consisting of a silty sand with some clay while rounded and angular blocks were scattered throughout. No traces of stratification were found.

Seismic refraction traverses were carried out along a line parallel to Mertoun Bridge and some 50 yards upriver from it crossing F513 and 517. The results, tied only to river bank sections, are tabulated along with the interpretations of the data as, sets 39 to 44 in appendix 4. Figure 6.4 illustrates the meaned results of three double traverses, showing in two cases a relatively shallow depth to bedrock while at the other point till was probably encountered. The shallowness of the drift at this point is consistent with the exposure of rock above the water surface at 6082 3232, some 300 yards away across the river (Plate 17).

Miller's (1883) classic study "River terracing: its methods and their results" was built up in part on observations derived from the Dryburgh area. He claimed that Milne Home's (1875) data substantiated his contention that only rarely do paired terraces exist in the Tweed Valley.

<u>C. Bemersyde Gorge to Abbotsford</u> (Figures 6.1 and 6.2)

Upstream from Old Melrose, the Tweed remains incised for a farther 1.7 miles. In this stretch it is joined by the valley of the Leader, from which only low fragments issue into the main valley. It is probably significant, however, that F487 on the south bank attains its greatest width slightly downstream from the Leader/Tweed junction, pointing to the effects of water from the former in promoting erosion of this bank of the Tweed either before or at the time of formation of Ravenswood Haugh.

Ravenswood (5895 3417) itself is built upon a spread of what is believed to be sand with a little gravel. This is clearly derived from a stream occupying much of the present course of the now incised Bogla Burn and it terminates some 60 feet above the Tweed. The extent of human modification of the flat is unknown but unlikely to be extensive except around Ravenswood House.

As elsewhere, terrace and ice-contact landforms are much more plentiful outside the gorge tract: both east of Abbotsford as far as Melrose Bridge and north of the river, mainly in the valley of the Allan Water, fluvioglacial features are preserved in their most varied expression within the Tweed Valley. These mounds, ridges and sheets of sand and gravel were tabulated in part by Haldane (1948 p.13). Entirely absent or buried in the broad, flat-floored depression east of Darnick (532 344), they lie within an approximate range of altitude of 320 to 390 feet on the south side of the river and up to 500 feet on the north side, west of this village.

The ground surface south of the river and Lowood House (5210 3526) consists of several main elements, including kettle holes ranging in size from the 600 yard-long,partly infilled dead ice hollow around 515 347 to others only a few yards across and 2 to 3 feet in depth. The numerous mounds, many slightly elongate,are interpreted as kames as their internal constitution is everywhere seen to be sand and gravel, usually bedded. For example, at the gravel pit at 5242 3490 several feet of well rounded stones up to 9 inches diameter lie sub-parallel to the ground surface in a sand matrix. The orientation of many of these ridges, such as that running through 513 344, is approximately west to east, although local variations from southeast to northeast trends do occur.

As well as kames and kettles, flat sheets of sand and gravel are common in this area. Most of these are provisionally interpreted as outwash on the basis of their relationships to the kames and kettles, many of which are upstream from and below the level of the main sheet whose surface expression is F431, probably continued as F435 and possibly as F439. That this main sheet also contains kettle holes, largely buries other kames and, most important, is separated from the main mass of moundy sand and gravel by a marked ice-contact slope is further evidence for this explanation. The ice-contact slope (Plate 19) runs eastwards for 450 yards from 5185 3462 then swings northwards for a similar distance until it fades away near the railway line at 5224 3492. A gravel pit in the outwash, now being filled by refuse, showed approximately 10 feet of well rounded stones up to 8 inches diameter very tightly packed with only a little sand as matrix. Little bedding was thus visible except at the west end of the pit where current bedding in a fine gravel lens was exposed. In places around 5210 3451 large boulders, derived from the immediate vicinity, were found on the bottom of the pit.

Boreholes were recently taken along the line of the proposed Lowood bridge, crossing the Tweed from 5080 3479 to 5101 3464 and thus impinging on F403, an extremely flat fragment on a westerly projection of which Abbotsford is built. Figure 6.5 illustrates the section obtained. With the solitary exception of a 5 feet thick layer in bore 7 described as a "very sandy clay including fine to coarse gravel" all of the bores found only sand and medium to coarse gravel with occasional boulders. It is noteworthy that only numbers 7,3a and 5 reached rockhead and thus while 50 feet of fluvial sediments are known under F403, it could conceivably be very much more. The nearest known outcrop of bedrock is approximately 650 yards to the southeast of the river at this point.

A considerable thickness of drift deposits on the left bank of the river is also shown by these bores and by other exposures and was suggested by Haldane (1948 p.12 & 13). An anastomosing esker system with associated kettle holes runs north-eastwards from 5016 3390 for 450 yards, apparently related to water flowing both down the Tweed Valley and also down that of a small tributary. Subdued kames and kettle holes were found just to the north and northwest of the Convalescent Home (5060 3465). These are separated from much lower kames, some 25 to 35 feet above the Tweed, by what may be an ice-contact slope running southeastwards from 5050 3488 to 5086 3480, parallel to the trend of the Gala Water. Exposures in the lower kames showed 10 feet of near-horizontally bedded fine sand with lenses of gravel which was up to 4 inches in diameter. At similar altitudes on the north side of the Gala Water,other kames were noted by Haldane (1948 p.13) but are now partly obscured by building.

The dangers of detailed mapping in an urban environment are well illustrated by F428, a 600 yard-long flat terminated at 5000 3531 by two mounds of sand and gravel, the long axes of which parallel the Gala Water. Mapping and levelling of this flat were complete before 4 boreholes taken in Croft Street were discovered. These showed made ground, varying from 2 to 8 feet in thickness overlying 4 to 9 feet of hard packed sand and gravel overlying rock. Despite this, the heights on the fragment have been retained as they are still believed to be useful provided a much larger error range than normal is accepted. No such qualifications need to be made about the high fragment 422, located near the junction of a large northeast-trending meltwater channel and the present Gala Water valley. Poor sections under this showed the terrasiform deposits to consist of at least 3 feet of stratified silt, sand and fine gravel with occasional boulders up to 2 feet in diameter.

Northeast of Galashiels, particularly in the Allan Water valley, kames and kettle holes are exceptionally frequent and well developed with an overall long axis orientation of the longer ridges from west to east. Numerous exposures in the gravel pits in this valley revealed great variations in particle size associated with considerable lateral variation in the deposits. Section 19 illustrates a fairly typical exposure in the kame complex around 519 363. The deposits are economically valuable because of the non-existence of coal erratics, believed by many to be deletrious in concrete. Thus the recent appearance of black, carbonaceous specks caused some concern but the quantities found proved to be insignificant. One section showed a highly cemented fluvioglacial conglomerate with a crushing strength comparable to some of the surrounding bedrock.

South of these kames, a half mile-long esker, paralleled on its southern flank for half this distance by a meltwater channel, runs slightly south of east from 5185 3600. The dry channel appears to be closely related to F442 and its upstream northeast-trending end is paralleled by another like feature terminating at Easter Langlee (5185 3574). Slightly below this second channel lies F440, a 400 yards long, 150 yards wide terrace fragment with a kettle hole near its southern ruin. Exposures in the banks of the river below this remnant show gravel down to the water level at 5175 3550 with rock-head emerging a few yards downstream and attaining an altitude of 20 feet above the river some 100 yards further downvalley. Observed under F434 at 5120 3520, an interesting exposure is reproduced as section 20 in appendix 6 and seems to represent fluvial infilling of an eastward trending channel cut in till, some 10 to 15 feet above the present Gala Water.

Apart from the terrace fragments already described, none of the many others along this section of the river is known, from morphological evidence, to be directly associated with glacial events. Fragment 427 in the grounds of Lowood House, some 30 feet below the level of F431, is above the floor of some of the dead ice hollows, particularly that noted opposite the junction of the Tweed and the Gala Water, filled up only to the level of F409, roughly equivalent in height above the river to F425. The channel at the rear of F427 is irregular and may be a string of linked kettle holes.

Low terraces are extensive, particularly in the broad valley to the east of Melrose where the lengthy, partly-infilled channels and fringing well-developed lower features suggest the mile-long F461 is essentially a relict feature. Much the same conclusion can be drawn from parts but not all of the haugh areas around Gattonside (554 350). The steep banks backing both F461 and 466, markedly different to the gentler slopes above, suggest that much lateral erosion occurred previous to or contemporaneous with the formation of both fragments. If this did not occur recently, then the present river may not be responsible for the steep till section at 5595 3498, an eastwards continuation of the backing scarp of F466.

Some of the low terraces seem to be related not only to the main river valley but also to a now-small tributary, the Toft Burn. Fragments 451 (truncated by the lower fragments F447 and 449) and 459, approximately the same altitude as F461 near their junction north of St. Marys Road in Melrose, seem to reflect two different courses of this tributary. It may be, however, that much of F459 is artificial as a section cut for drains showed the underlying 5 feet of material to consist of cinders, overlying clay in Greenyards Park, Melrose.

Milne Home (1875 p.525) recorded similar infilling of a dry channel cutting a low terrace near Gattonside, in 1825.

D. Abbotsford to Holylee (Figure 6.2).

This section of the Tweed Valley is restricted in width throughout and the pattern of deglacierisation and the resultant landforms are rather different from those in the wide valley section downstream from Abbotsford. The lower Ettrick Valley is midway in size and form between the two sections of the Tweed. Numerous kames and kettle holes exist within the tributary valley, particularly around 470 296, known locally as the Tod Holes. Some of the rims of these kettle holes replace all but the lowest terrace, being only 15 to 20 feet above the Ettrick while the centres of the depressions are occasionally below this level. Such kames and also eskers are common downriver as far as Sunderland Hall (4805 3185) and seem to be particular -ly frequent where small valleys and minor embayments are etched into the hills.

As the ice-contact features and terrace fragments within the Tweed Valley itself seem to be closely related and can be grouped into three distinct systems, they will be described in such a fashion.

i) The Holylee - Ashiesteel system.

Between Kaim Knowe (3835 3766) and Thornielee Old Toll House (4080 3626) exists a complex esker system with intervening kettle holes, particularly well marked around 399 365, and a general lack of all but very low terrace fragments. Downstream from here as far as Caddonfoot (4480 3480) extends a series of well-marked terraces with no ice-contact features whatever. Several of the eskers and meltwater channels such as that running south-westwards through 3950 3780 must have been formed by water running directly downslope while others, like that at 3857 3782, parallel the trend of small-scale tributary valleys. In contrast with these, some eskers were found to parallel the contours, as at 3890 3776 and one abruptly changes from this to the downslope made at 3907 3783. Perhaps the majority of these elongate ridges, however, are positioned irrespective of the underlying topography. The crest line of that described by Eckford and Manson (1925), Kaim Knowe, rises 25 feet in 100 yards (Plate 24) while others, typified by that commencing at 3916 3734,rise as much as 50 feet in a downvalley direction. One esker at least has a marked up and down long profile.

Due to their remoteness from the river and human activity, few sections exist in these features, the prime exception being the riverside exposure in Kaim Knowe. Although revealing sand, gravel and large boulders up to 4 feet across at present, the section is poorer than when investigated by Eckford and Manson. They recorded (1925 p.314) "a great assortment of boulders and pebbles mixed with sandy clay. It (the esker) shows a rude stratification somewhat inclined." Many of the large boulders washed out of this feature are incapable of transportation by the present river and now form rapids at low water stages of the Tweed. Most of the other ridges contain small sections which show sand and gravel to be present, often with boulders up to 2 feet in diameter, confirming the morphological interpretation of their origin.

Two small gravel spreads occur at Gatehopeknowe (3856 5767) and at Holylee House. Both are too irregular to merit the description 'terrasiform'. The same cannot be said of F335, a flat-topped ridge in the middle of the valley, underlain by sand and gravel, isolated from the bank by a dry, humped-profile channel and from the river by a low fragment (F333). An esker commences at 3945 3710, well below the level of F335 and, rising southeastwards, attains an altitude of approximately 20 feet above the remanant before falling slightly downvalley.

The first of the suite of terraces apparently not intimately associated with these eskers begins at 4102 3633. However, a narrow bench (F364) which, on morphological evidence, seems to have been cut in both drift and rock, commences vertically above the last of the eskers at 4016 3665. The best developed of these high fragments, F347, runs intermittently downvalley for 1200 yards. After a gap in the sequence in the vicinity of Peel Hospital (429 350), like features resume in the vicinity of Ashiesteel Bridge (4375 3505), terminating some 1100 yards down-valley. Only the largest remnant, F347, is punctured by a kettle hole. A dry channel cut into the scarp fronting this fragment at 4190 3605 ends by debouching a small fan on F349, the next fragment below. The lack of any continuation whatever suggests that this may have been cut before F347 became a relict feature. All but the lowest flats are littered by stones, usually rounded and up to 3-4 inches diameter but occasionally up to 12 inches across. The only section known at present in the underlying terrasiform deposits is at 4156 3637 where two limbs of a monoclinal fold in coarse and fine gravels interbedded with sand were noted.

While not directly associated with the terraces and presumably an earlier feature, the enormous north east-trending meltwater channel commencing at 4355 3525 is of interest as the floor of the channel at this point is only a few feet above F378 and, probably, F359. The channel, following the general trend established by Price (1961) in the Tweed Basin west of Innerleithen for like features, rises some 100 feet to its highest point at 4402 3565 then falls slightly north-eastwards. The existence of an elongate kame in the bottom of the channel at 4435, 3580, associated with the probable link between this channel and that running from Clovenfords to the north of Galashiels points either to the subglacial formation of this channel by water under a hydrostatic head of pressure in the last glaciation or modification at that time of an earlier feature. The second section of this composite channel, extremely straight for at least 2 miles, was shown by Sissons (1967a p.104) to swing southeastwards at its termination to coincide with the present Gala Water Valley, a short distance upvalley from F422.

2) The Fairnilee System

Around Fairnilee (458 327) extends a series of terrace fragments ranging from F384, some 60 feet above the river, to others only about 5 feet above normal water level. These may well be an extension of those in the Ashiesteel area but are separated from them by a mile of valley in which only low, or small and dubious higher forms, exist.

In a disused pit at 4593 3274 underlying F392, poor sections showed rounded gravel up to 6 inches in diameter in yellow clean sand of unknown depth. Occasional boulders up to 2 feet in diameter were also present in the exposure. Mounds below the 500 feet contour from about 4710 3270 to Rink Farm were taken to indicate the presence of sand and gravel, partly based on the small sections noted in the opposite bank of the river at Howdenpot Knowes (4740 3223). Here, some 50-70 feet above the river, great difficulty was found in mapping eskers and meltwater channels under a tree cover. At least 8 feet of yellow fine sand was found at one spot. Nonetheless this cover of stratified drift is not ubiquitous throughout the area. A trench, dug uphill from 4508 3387, commencing at an altitude of 500 feet, showed medium brown clay with occasional sub-angular stones to be overlain by a few inches only of fine, yellow-brown sand. The clay with stones is interpreted as till.

3) The Ettrick-Rink System

Unlike the Holylee-Ashiesteel system, that around the junction of the Tweed and the Ettrick is notable for the intimacy of ice-contact forms, kames, kettle holes and eskers, with terrace fragments. Thus F410 emerges from a kame-like ridge and extends for 800 yards downvalley while below it exist complex esker and kame forms, some cut by dry channels leading from higher kettle holes. The two largest esker systems mapped on the north side of this section of the Tweed were that commencing at 4795 3230 and running eastwards, paralleled immediately to the north by a meltwater channel, and the other commencing at 4843 3225 and running east-northeastwards between a kame and kettle complex and F412. At 4891 3268, the rim of a kettle hole is only some 7 to 9 feet above the lowest terrace fragment in the area and is well below the level of F412. This kettle hole is only partly infilled, mainly with vegetation. Northeast of Cascade House (4900 3291), the greatest number of kames exist on the right bank of the river, trending towards the Abbotsford system or towards the present river.

In the vicinity of Sunderland Hall and to the southwest numerous eskers, kames and meltwater channels exist, some of which were noted by Haldane (1948 p.12). The trend of all the ridge forms is approximately northeastwards, diagonally down and across valley. South of the Tweed, little of the intimacy of contact of kames and terraces, visible only a few hundred yards to the north, occurs. Only F383 and smaller fragments such as F379 and F381 are in close proximity to obvious ice-contact forms. The last mentioned pair of fragments may be in part artificial.

Sections in this area are almost non-existent. Small exposures under the west end of Sunderland Hall contained rounded stones between 0.2 and 4 inches diameter in a sandy matrix. A trench dug down the slope in front of the Hall in 1967 is said to have revealed at least 26 feet of sand and gravel. Disused gravel pits under the down-stream end of F412 still show 2 to 3 feet of the very much thicker mass while the flat is littered with rounded stones. Sections in non-terrasiform deposits of sand and gravel, showing up to about 4 feet in both cases, were noted at 4900 3166 and 4854 3112

Unlike the situation at the Teviot-Tweed junction where a terrace fragment complex occupies the area between the two rivers, one large low flat, F385, exists between the Ettrick and the Tweed. This and adjacent low terrace fragments are scarred by several dry channels and are rarely stoney, but usually of a sandy loam texture. Riverbank sections show this composition to persist at least as far downwards as the water surface, some 4-6 feet below, except for occasional gravel lenses.

The immediate area of Rink Farm contains one of the few prolific pre-historic sites known in the Tweed Valley (Lacaille 1954 p.162). Very large numbers of microliths or pygmy flints have been found here, mainly within the lower regions of the field whose centre is 4850 3225 (Mulholland 1966). Other flints have been found across the minor road to the north-east while the owner of Sunderland Hall recently reported finding others at 4792 3155 (pers. comm.). Geomorphologically the most significant is a group found at 4885 3230 on the rim of the lowest terrace fragment (414). If these are in situ and, although the remnant is only some 25 yards wide at this point, the rear being marked by slumped sand and gravel from underneath the higher F412, there seems to be little possible doubt of this, at least parts of F414 must predate the Mesolithic age assigned to the artifacts. Owing to the stagnation of primitive economies in remote areas like this, archeologists generally refuse to give any absolute dates for the Mesolithic period in the Tweed Valley. Nonetheless most would agree that the implements are unlikely to be younger than 4-5000 years old.

E. The Holylee to Neidpath Gorge Area (figure 6.3 and 7.1)

The only recent study of deglaciation in the Tweed Valley is that by Price (1961). He mapped all the meltwater channels in the upper Tweed Basin west of Innerleithen together with the associated fluvioglacial deposits, although concentrating on the former. His conclusion was that most of the early stage meltwaters flowed northeastwards away from the centres of ice dispersion (Price 1960 p.488, Sissons 1967a p.106). Most of the channels carrying this meltwater were initiated en-or subglacially, becoming superimposed onto bedrock or pre-existing drift in the former case as the ice downwasted. At later stages, Price suggested, meltwaters often reverted to drainage lines down pre-existing valleys. Thus in locations where the new drainage was south-flowing, complete reversals of drainage orientation must have taken place at some stage in the disappearance of the ice.

The change in valley cross section from the narrow form prevalent below Holylee to the broad U/V shaped valley above that point coincides with a marked diminutution in the number of high terrace fragments, ice-contact landforms and low level meltwater channels, all indicators of the orientation of meltwater drainage. Low level kame-like masses are restricted to an 800 yard-long zone stretching eastwards from Juniper Bank (3740 3738). Small sections and local information confirm that these few mounds are formed of sand and gravel. Some fifteen years ago, one of these landforms was bulldozed flat and is now a small well-defined terrace fragment, apparently comprising part of F331. It is possible that ice-contact fluvioglacial forms did exist in this section of the valley but have been subsequently buried by the lowest terraces. Kames and kettle holes exist in the area around 323 352, incorporating meltwater channels which appear to feed terrace fragments 307 and 309. These remnants are over 100 feet above the river surface but the hollow at 3280 3515, believed to be a dissected kettle hole, extends very much below this level.

In comparison with most of the other tributary valleys in this section of the Tweed valley, the Walker Burn terminates only in a small fan, rather than in an extensive flat-topped sheet of sand and gravel. Some 500 yards down Tweed from this small fan, a well marked fragment (354) occurs and a section under this revealed at least 4-5 feet of sand and gravel. The latter was mainly under 1 inch in diameter but occasionally up to 3 inches across and showed rudimentary horizontal bedding. A much larger fan (F321), certainly relict as it is clearly truncated by the lower remnant F317, emerges from small north-trending valley at Glenbenna (367 367). Fragment 319 may represent an earlier but similar feature.

A large mass of sand and gravel is known to exist in sheet form in the mouth of the Leithen Water. Apart from F350, it cannot be ascertained from mapping alone whether the higher elements, represented by F342 and 338, are primarily related to the Tweed or to the Leithen. Sections under F340b, on which houses and a road have been built, leading to some modification of the surface, showed 12 feet of well-rounded stones up to 3 inches diameter in sub-horizontal bedding, with a sandy matrix. This is probably the same section referred to by Haldane (1948 p.10) as consisting of 15 feet of gravel overlying 6 feet of fine sand. Construction works on F350 permitted the observation of a small section, consisting of 12 inches of made ground (road) overlying at least 3 feet of well- and sub-rounded gravel 1 to 12 inches in diameter and near-horizontally bedded in a sandy matrix. A lens of fine gravel was noted in the middle of the coarser material, thinning towards the back of the remnant. In the 40 yard-long trench, the material was seen to become finer towards the bank while a 40 feet wide shallow surface channel, probably similar to many of those found on the low terraces at the present day, was completely infilled by silt and clay. At the rear of this fragment (3361 3689) 4.5 feet of stoneless silty clay was found on top of gravel, suggesting some downslope movement onto the terrace remnant. Bores in this area have revealed the presence of approximately 90 feet of sand and gravel (Carter 1966 pp.17 &18) overlying rockhead.

It is manifest that the lower fragments in the vicinity of the Leithen Water/Tweed confluence are primarily related to the latter river. They are incised into the higher fragments and are approximately sub-parallel with the Tweed. A typical riverbank section, observed at 3362 3615, consisted of 3 feet of silt and fine sand with few stones overlying 1 foot of large gravel, up to 6 inches in diameter. A section at 3027 3926 showed 4 feet of silt and sand with gravel lenses, dipping more steeply than and consequently disappearing below the river surface.

Events in the deglacierisation of the Eddleston Valley are known in much greater detail than those elsewhere in the Tweed Valley owing to the work of Sissons (1958). He stated that the early stage northeast orientation of drainage, causing the deposition of kames in an englacial water table related to two northern col levels, eventually broke down and was replaced by subglacial meltwater drainage to the south. Some manifestation of this reversal of drainage might reasonably be expected in the Peebles area. In fact, this town is built on a large sheet of gravel, the surface of which is some 35 feet above the Tweed and which was mapped as F280 and 282. A bore at 2494 4097, quoted by Carter (1966 p.14), shows a thickness for this drift of 104 feet, consisting of mud, gravel and sand with clayey mud. Bore number 4 at this site (on the I.G.S. files) showed moss to exist 12.5 feet below the ground surface. Cut into the margins of this sheet of gravel, which extends for more than a mile along the Tweed Valley but only some 500 yards up the Eddleston Water Valley, are several lower terrace remnants such as F274, 276, 278 and 284.

Comparable forms south of the river at this point are not as well developed although they do exist, probably represented by F269 and 271. A large channel separates these two fragments and is already partly infilled with refuse. Downstream from this point, F271 becomes very extensive, attaining a width of 800 yards between 266 390 and 266 398. Part of this may be related not to the Tweed but to the now-small stream draining the Cademuir channel. The terminal ridge, transverse to the latter valley at 2580 3922, which ends some 65 feet above the Tweed, may be a moraine although a similar ridge to the northeast is known to be formed entirely of rock. The only known sections in the terrasiform deposits south of the river were recently provided through excavation for housing sites in Kings Meadows (256 398). A trench 100 yards from and parallel to the

Traquair road showed 5 feet of fine gravel to overlie the same thickness of coarser gravel, up to 9 inches in diameter. The few traces of bedding visible seemed to be horizontal and undistorted. Some 400 yards to the south at 2571 3970, 3 feet of small gravel was again exposed but adjacent hill slopes were found to consist entirely of a heavy clay.

Elsewhere in this area apparently-relict terrace fragments are best developed between the Gasometers (271 398) and Horsbrugh Ford (299 393) on the north side of the river, continued on the right bank from Cardrona Mains (301 390) to Cardrona and finally terminate some 1400 yards farther downvalley on the left bank below Velvet Hall Cottages. Some of the higher fragments, such as F300, 332 and possibly 291, are punctured by kettle holes.

Broad low terraces are ubiquitous throughout the area. Most are heavily scarred by presently-dry channels indicating scour routes in time of flood or a change in lateral position of the Tweed. A comparison of John Ainslie's map of July 1774 with the present situation shows that a braided section of the Tweed flowed through the now-abandoned cut-off at 345 371 and also in the present southerly course at that time. Some dry channels are certainly due to human interference: the river was diverted in the region of Traquair House in the seventeenth century to prevent further undercutting of the foundations.

F. Evidence for a Buried Valley of the Middle Tweed

In comparison with the Lower Tweed, little evidence is available on which to construct any hypothesis of the depth of infill of the Middle Tweed Valley or its tributaries and the presence of any completely buried valleys.

The presence of alternating gorge and open sections of a valley has often been the stimulus to discoveries of completely drift-plugged sections. It has already been noted (Chapter 4) that A. Geikie postulated the presence of a sinuous, completely buried channel under the broad terrace remnants east of Darnick and Melrose. Equally, it has been concluded (Chapter 4) that the sections in the Newstead and Mertoun Mill areas do not necessarily imply the presence of this buried valley. However, a most suggestive hint of a buried valley now short-circuited by a gorge was noted between 670 320 and 685 333. Here a broad, low depression parallels the rock-walled and -floored gorge of the present Tweed and is known to include both till and fluvioglacial deposits. One part of the depression is separated from the present Tweed only by F578 and the steep-sided, sand-covered ridge commencing at 6786 3215 which has already been discussed (Section A). It is likely that the flat floor of the depression is at least in part a continuation of F578.

All the other evidence available pertains to the depth of infill in the present Tweed Valley. At locations such as within much of the Makerstoun gorge and at 471 324, rock is exposed in the valley floor. The latter spot is particularly significant as it is only a short distance up-valley from the recent bores for the proposed Lowood Bridge showing a minimal infill of 57 feet while several bores in Selkirk (Carter 1966 pp 26-30) show equivalent values of the order of 43-60 feet. It should be noted, however, that bores through the lowest terrace fragment at Galashiels show only 12 to 35 feet of infill (Carter pp. 21-22), while bores for Drygrange Bridge (5752 3477) in the upstream end of Bemersyde Gorge show only 10 feet of sand and gravel in the river bed, together with 2 to 11 feet of soil and sandy clay with stones on the southern bank. Nonetheless the bores at Peebles and Innerleithen already described suggest that in the broader sections of the Tweed, the infill is very much thicker. It seems reasonable to infer from this that glacial erosion may have contributed significantly to the valley bottom form in these areas.

CHAPTER 7.

TERRACE FRAGMENTS AND RELATED FLUVIOGLACIAL FEATURES BETWEEN NEIDPATH GORGE AND TWEEDHOPEFOOT.

A. Neidpath to Stobo Castle and Wester Happrew. (Figure 7.1).

The area surrounding the junction between the rivers Lyne and Tweed contains remarkable ice-contact and other fluvioglacial phenomena comparable only with the Abbotsford and Cornhill-Crookham complexes. In marked contrast to this, the Tweed-Manor junction is totally undistinguished by any such features, suggesting that drainage until a relatively late stage escaped via the Cademuir Channel. In discussing the ice-contact and intimately related terrace fragments, each valley will, for convenience, be considered in turn.

1) The Tweed Valley. Price (1961 pp. 62 - 108) mapped the melt-water channels and fluvioglacial features in this area. He concluded that as the considerable thickness of gravel in the Stobo-Easter Happrew area was apparently overlain by an esker and also because little evidence was found of any alternative explanation, these deposits may well have been formed subglacially. This was based on the belief that the surfaces of these terrasiform deposits are horizontal (derived from heighting with an aneroid barometer) but at different levels. Their extensive, relatively flat-topped nature led Goodchild (1902) to suggest that these were lacustrine forms, while Sissons has also differed from the Price interpretation by suggesting that much of the sand and gravel was laid down in a pro-glacial environment, perhaps marking the limit of the Perth Readvance in this area (pers. comm.).

Mapping of the fluvioglacial depositional features showed that the Sheriffmuir Esker, using Price's terminology, commences as two sub-parallel ridges above Stobo Church (1827 3765), is truncated by a large northeastward-trending meltwater channel, and then runs virtually continuously for a mile, terminating at 1903 3873. A section in this feature at 1870 3848 showed 8 feet of coarse gravel (Plate 29) up to 1.5 feet diameter, with relatively little sand present. Downvalley from this occur several poorly defined flat-topped gravelly mounds, interpreted as terrace fragments and heighted as such. These in turn disappear downvalley and are succeeded by a much higher complex of mounds of sand and gravel, cut by numerous dry channels, the courses of which often truncate higher like forms. Two such channels unite at 1983 4044 and, forming a 25 feet deep flat-bottomed valley between F 214 and 216, run northeastwards until abruptly truncated by the present Lyne Water. The majority of these mounds are interpreted as kames and eskers on the basis of their morphology and internal constitution although it is probable that two elongate ridges at 1977 4023 and 1970 3995 are dissected remnants of a once-continuous surface between F 216 and 214.

Fragment 216 is some 80 - 90 feet above the present Tweed surface yet even higher fragments do exist. Remnant F 212, for example, appears to be about 60 feet above the surface of the main flat. Both of these are pitted by a few kettle holes, the largest of which occurs at 2021 4020. An entirely closed, steep-sided depression, some 20 feet deep, this is only a few yards from the front edge of the fragment which overlooks the river Lyne. The suspicion that a feature such as this, very much larger than all others in this area, may be artificial is unlikely to be justified. It is improbable that this was a gravel pit as sources of good gravel are found all along the main roads and also gravel is usually most easily extracted by digging into pre-existing banks.

Features on the eastern bank of the Tweed are far more poorly developed than those on the west. Although sand and gravel is found at least as high as 650 feet O.D.,illustrated by numerous small sections in the woods around 1945 3840, the morphological expression of this material is rarely sharp. In general, it consists of a series of small elongate terrace fragments separated by moderate slopes. Unlike the situation northeast of Stobo, where shallow kettle holes were found on a terrace fragment (F 190) only some 25 feet above the river, the eastern bank terrace remnants are usually smooth or so dissected as to render recognition of dead ice hollows impossible. The only large fragment (F 237) immediately upvalley from Barns (2163 3924), is scarred by two now dry-channels but also appears free of kettle holes.

Numerous small sections occur in the ice-contact and terrasiform deposits of this area yet the only large section known is in the Sheriffmuir esker and has already been described. The owner of Easter Happrew described a road cutting at 2004 4033 in the deposits underlying F 216 as consisting of at least 20 feet of sand and gravel which included a vertical lens of blue clay. Today the section is almost completely overgrown but well-rounded gravel and boulders up to 1 foot in diameter still litter the surface. He also claimed that the top few feet of deposits around 2040 3999 were almost gravel-free, consisting of loosely bound sand. All the fragments are littered with stones except where obscured by a vegetation cover and, in general, the higher the fragment, the larger are the stones found on it. On F 198, for example, few stones approach the maximal diameter of 12 inches, most of the surface being covered by gravel which ranges in size from 0.1 to 1.0 inches across.

The fragment vertically above this, F 202,is strewn with boulders up to 2 feet across while small gravel is much rarer than in the previous example.

The general unsatisfactory nature of the knowledge of drift thickness in the area led to the undertaking of a number of seismic refraction traverses around the margins of the largest fragment, F 216, and across F 208. The results and the interpretations are summarised as sets 9 to 30 and tabulated in appendix 4. Figure 7.3 shows the depths to rockhead along a line of section parallel to the course of the Lyne. This suggests that although surface variation in height is small in the main, bedrock forms buried ridges in the centre of the section. Depths of 60 feet of sand and gravel are quite common, revealing the considerable commercial value of these terrasiform deposits. It must be stressed, however, that these interpretations are not tied to borehole evidence and therefore can only be regarded as provisional, particularly as in those cases where a fourth stratum was discovered, an approximation method was employed to calculate the depth to the interface between it and the overlying deposits.

2). The Lyne Valley. The most striking feature of the high terrace fragments in the Lyne Valley is their abrupt termination at Five Mile Bridge (1864 4078). Upstream from here only a low terrace, some 3 feet above the water level, persists for at least as far as 165 430, with the exception of fans of at least three different periods at the junction of the Drumerlie and Tor Burns (1735 4163) and a single very much higher and probably unrelated flat at Ladyurd (149 427). Large channels, some entirely dry and believed to be largely due to glacial meltwaters, crease the northern bank of the Lyne in this area while the rock outcrops at 1820 4098 and 1750 4134 testify to the thin drift deposits on the opposite valley side. Only at 1746 4148, where a section showed 15 feet of bedded sands and gravels, presumably related to an ancestor of the present Tor Burn, is the depth of surficial material known to exceed 2 - 3 feet. Approximately 3.5 miles upvalley at Ladyurd an extensive flat once existed at approximately 860 feet O.D. Sections in the gravel pit now present showed 10 feet of foreset, even bedding overlain by 5 feet of topset beds, made up of coarse sand and gravel. No kames and kettles, or similar flats were observed in brief investigations in adjacent areas.

Downvalley from Five Mile Bridge, the situation is very different. Terrace fragments such as F 222, some 110 feet above the river, are ubiquitous and while a large rock outcrop at 1870 4075 reaches to within 8 feet of the surface at this point, it is clear, from such sections as that at 1849 4069, that most of the terrace remnants are underlain by considerable thicknesses of sand and gravel. The section at 1849 4069 shows hard-packed gravel, up to a foot in diameter, lying 25 feet below the surface which constitutes F 224. A stone count at this point, employing 100 stones picked at random, yielded results tabulated in appendix 5. These show a preponderance of Central Valley erratics, indicating that this section of the terrasiform deposits may have had a northwesterly origin.

Fragment 222 is large and has a marked backslope. On it or rising through it, above Hallyne, is a small esker or kame: a section in this at 1906 4058 showed inclined beds of fine to coarse gravel with boulders up to 1.5 feet diameter in a silty clay and fine sand matrix. The inclination of the beds was approximately parallel with that of the surface. A stone count in this exposure (appendix 5) also revealed that many of the stones may have had their origin in a northwesterly direction. The relationship of the ridge to F 222 is complicated by a dry channel, west of and parallel to the overall south-southeast trend of the esker. A similar but smaller ridge, believed to be composed of sand and gravel, underlies Hallyne Church and is orientated from west to east, apparently below the projected level of F 222. Traces of these high terraces continue as far downvalley as about 201 407 although here the cross profile is manifestly sloping towards the front of this particular remnant. The termination of these features virtually coincides with the presence of a north to south, 30 feet deep dry channel and, east of this, kame-like ridges of sand and gravel exist at comparable altitudes.

At much lower altitudes, numerous other terrace remnants appear to be clearly related to a water flow down the Lyne and are chiselled into or built up against the higher features e.g. F 232, 236, 238 and 240. In the area of Lyne Station (209 400) these merge with similar Tweed terrace fragments and some complexity of form exists.

Between the junction of Tweed and Lyne and downstream as far as Neidpath Gorge only two other areas of terrace fragments are worthy of comment. The first of these contains F 266 and 268, some 50 feet above the Tweed and underlying Edston Farm (222 394). These emanate from a south-drain-ing tributary valley and while the former slopes markedly towards the Tweed, the latter appears to have a more normal cross profile, suggest-ing affinities with Tweed waters. Numerous small exposures half-way up the frontal scarp at 2206 3927 prove the terrasiform deposits to consist of coarse gravel. The second area of interest is the arcuate now-dry channel, whose floor was mapped as F 247 and 255. As the upstream lip of this is only about 6 feet above the present river, it is likely that this is a recently abandoned course of at least part of the Tweed. Smaller terrace fragments and intervening slopes make up the meander core. A poor section below F 249 at 2212 3909 showed at least 5 feet of sand and gravel, the latter up to 6 inches in diameter. Low terrace fragments, within a few feet of the river, are ubiquitous throughout this area and, as elsewhere, these surfaces are free from the extreme stoneyness of higher flats but scarred by more shallow dry channels.

B. Stobo Castle to the Crook Inn. (Figures 7.1 and 7.2).

This section of the Tweed (and associated sections of its tributaries) can be briefly summarised by stating that it is composed of two areas of a high terrace density, separated by other areas in which virtually only one low terrace prevails.

1) The Barren Areas. The first of these is that from Stobo Castle to Drumelzier, including the Biggar Water valley as far upstream as Broughton. Only F 209 and a kame and kettle complex immediately below it, west of Bettspool (161 352), diminish the monotony of the terrace sequence although stratified drift of amorphous surface morphology is exposed in several locations such as at 1659 3569. Here 4 feet of sand and gravel, the latter having a maximal observed diameter of 9 inches, was seen.

From about 123 330 to Logan Cottage (1083 2892), a similar pattern is present, although small kames and kettle holes fringe the banks above the solitary low terrace in parts, as around Rowanbank (1199 3221), while a high-level fan underlies Mossfennan and low-level fans emanate from small tributary valleys at Hopecarton (127 309) and Easter Stanhope (122 297). A section in the Hopecarton fan is reproduced as section 23 in appendix 6. It is possible that part of these deposits was built up in contact with decaying ice, accounting for the contortion noted in the bedding. The terrace fragment F 132, some 30 feet above the river, is unusual in being underlain largely by rough subangular material. From the vicinity of this fragment upvalley as far as the headwaters of the Tweed, meltwater channels, often cut to depths of 30 feet in rock, become more frequent and sometimes appear to be associated with the terrace fragments.

A third, near-barren, stretch of 'low terrace only' valley commences near Chester Knowes (122 282) and continues upvalley for approximately a mile, broken only by small tributary valley fans, particularly at Polmood, and the presence of F 183.

2) The Rachan Area. This area is best considered in two discrete parts as these are very different. The first occupies the Tweed valley from about 123 330 as far downstream as the junction with the Biggar Water. Apart from the ubiquitous low terrace, no higher flats are present. In contrast, however, to the barren areas previously described, the hill slopes, particularly on the right bank of the river, are covered by northeast-orientated sand and gravel ridges extending at least as low as water level in the vicinity of Drumelzier Place (1255 3359) and poking through the lowest terrace as far downvalley as Deadmans Knowe (1322 3470). Other examples of these near-submerged ridges, interpreted as partly-buried kames, are Haggies Knowe (1310 3420) and that on which Merlindale (1300 3408) is built, while many similar features occur in Muckle Muir Plantation. Those adjacent to the river show no signs of ever having been subject to erosion or deposition from much higher water levels than exist at present. Frequently, too, kettle holes whose rims are only a few feet above the present stream level show no evidence of infilling.

The only terrace fragments apparently related to this section of the Tweed valley are those downvalley from the kames near Merlindale Bridge, F 205 and F 207. The former is rather irregular, backed on its river side by a kame while the latter in part at least seems related to the valley of the Drumelzier Burn. A section some 5 feet below the surface of F 205 and 35 feet above the river showed gravel and boulders up to 2 feet across in a sandy matrix,with quasi-horizontal bedding.

The terrace sequence in the Holm Water, the lower reaches of which parallel the Tweed in this area and are separated from it by Rachan Hill,is very different. No kames are known in this tributary as far upvalley as 108 335, except for a partly-buried example at 1142 3422. Both here and in the col channel between the two valleys south of Rachan Hill a complex of terrace fragments occurs, the highest part of which, F 136,is some 150 feet above the nearest part of the Tweed surface. Mapped evidence suggests that these remnants slope down the col channel from the Tweed to the Holm Water and merge with others solely related to agents operating in the latter valley. Some fragments are irregular, such as F 146,while many others are definitely pierced by kettle holes. In particular, two large depressions in F 156, centred at 1155 3445 and 1230 3460 may be parts of relict stream courses but appear more likely to have originated due to the burial of detached blocks of glacier ice. The rim of the second example, now occupied by a fish pond, is broken only at 1223 3467 where, for a few yards, the rim is only 2 to 3 feet above F 152.

The interelationship of these terrace fragments are not often obvious: while it is clear that F 152 cuts out fragments 146, 150, 156, 160 and others, morphological mapping evidence is not sufficient to distinguish age relationships in cases like the junction of F 150 and F 156, occupied by a large kettle hole. The only deep section underlying these remnants was found at 1102 3392, where a combination of the common small sections showed at least 20 feet of sand and gravel, with boulders up to a foot in diameter, to exist under F 146.

3) The Kingledores Area. A series of terrace fragments emanates from the valley of the Kingledores Burn, commencing at 1037 2802. Immediately upvalley, two large kames were mapped at 1020 2787 and 0992 2770, below the level of most of the remnants. Owing to consider-able and apparently recent dissection by the Kingledores Burn, exposures in the kames exist which reveal about 35 feet of sand, gravel and angular boulders up to 2 feet in length. Sand and gravel is also common on the northern slopes of this valley up to the level of F 126 where an abrupt transition to scree was found. It is possible that this scree is recent and only veneers further sand. The presence of terraces at the mouth of the Kingledores Burn valley and also diametric-ally opposite the junction of this with the Tweed valley, at Patervan (the latter suite being the only flats in this section of the Tweed, except for the floodplain), may well be significant.

The only good section exposed under any of the fragments in the Kingledores area is at 1083 2854, in the terrasiform deposits under-lying F 120. This showed 6 feet of partly subangular boulders (although many were rounded) with some sand in the matrix (Plate 32). Small sections and the usual extremely stoney surfaces suggested that at least most other terrace remnants are underlain by gravel. Seismic traverses carried out along a transect line down the middle and across F 112 provided results which are tabulated, along with their interpre-tations, as sets 2 to 8 in appendix 4. These results show an encourag-ing similarity in depths of gravel which has a mean value of about 25 feet. Interpretation of the depths to rockhead is very difficult in this area owing to the till and bedrock velocities being very similar. As in most previous cases, the results are not tied to bore-hole control and, despite their consistency, must be regarded as provisional until confirmation is obtained by other means.

C. The Crook Inn to Tweedhopefoot. (Figure 7.2).

A century ago Young (1864) published his notable early work on the evidence for small glaciers in the headwaters of the Yarrow and somw Tweed tributaries. This fascinating account has remained largely unamplified except for the work of Price (1961) and Sissons (1967a pp. 97 and 141). The former author accepted the conclusions of J. Geikie (1894 p.264) that the numerous moraines present were formed by a readvance, the so-called 'valley glaciation', and suggested that this should be equated with the Perth Readvance of Central Scotland. A much more likely suggestion, in view of the evolution of knowledge of glacial chronology made in the seven years since the publication of Price's work, was put forward by Sissons (1967a). Mapping these morainic deposits in the Upper Talla and nearby valleys, he was able to produce a map of the ice flow at the time of the last known glaciation in this area. Propounding that a small plateau ice cap existed at this stage, he implicitly suggested that these moraines represent the local equivalent on the Zone III Loch Lomond Readvance.

This section of the Tweed valley itself is unique in that all the higher terrace forms therein appear to originate in tributary valleys. Above the junction with the last major tributary near Tweedhopefoot no significant terrace forms are found in the main valley. Only low fragments, mostly small and carved from the higher remnants, seem related to the Tweed itself. It is likely that many of the intermediate and lower remnants are the projections of tributary valley fragments.

A proliferation of terrace fragments is thus found at the junctions of the main river and such tributaries as the Talla, Menzion, Fruid and Cor Waters and the Hawkshaws Burn. Even at the outlet of smaller valleys the fans, such as that at Hopecarton and Glenrusca (1060 2496),were found to represent at least two stages. The most extensive surfaces, however, those emanating from the Fruid Water (Plate 36) and the Hawkshaws and Fingland Burn valleys, are underlain by an unknown quantity of peat and drift and terminate upvalley by thinning towards the valley sides. In the case of the Fruid Water Valley, only a low terrace about 2 feet above the river is found for at least 2000 yards upvalley from the point where F 91 ends, and similar valley forms exist short distances upvalley from the exit in all the other tributary valleys.

Apart from the obvious peat cover, little is known of the terrasiform deposits underlying these higher flats. A section at 0560 1770 under F 1 showed 1 foot of yellow sand underlying an 18 inches deep peaty podsol, in turn underlain by 9 feet of deposits, the top 5 feet of which consisted of coarse gravel and boulders up to a foot in diameter while the remainder was obscured by slopewash. Another exposure at 0675 2189, under F 47, showed 18 feet of sand and rounded and subrounded gravel with odd blocks up to 2 feet across. The extensive slopewash concealed any sorting or bedding but some clay was noted in the upper layers. At 0683 2194, the deposits underlying F 51 were found to consist of 20 feet of rounded and subrounded gravel up to 7 inches across, tightly packed at the top and more loosely bound with sand at lower levels. Sections at the mouth of the Fruid around 0887 2323 showed a 35 feet high face to be partially obscured by thick slopewash but to consist in the main of fine red-brown sand with rounded and sub-rounded gravel and boulders up to 1.5 feet in diameter. Two hundred yards downstream, underlying F 103, a similar lithology overlay rockhead which is about 16 feet above the river at this point. No clay was seen in either of the last two exposures.

Attempts to make seismic refraction traverses over some of the higher flats were largely thwarted by difficulty in tripping the inertia switch owing to the low hammer deceleration rate on very soft peat. The only traverse completed, on F 91, suggests a thickness of peat of about 2 feet at 0859 2297. Elsewhere on the same flat the very much wetter and softer surface probably reflects depths of peat up to 5 feet or more. The results of this single traverse are tabulated as set 1 in appendix 4.

Apart from peat, however, two types of deposit unknown in areas adjacent to the Tweed outside this region were found and may underlie some terrace fragments. A section at 0555 1797 under what appeared to be a large fan emanating from the very small valley of the Badentree Burn is reproduced as section 27 in appendix 6. No stratification whatever was visible within each lithostratigraphic unit, many of the stones appearing to be orientated randomly (Plate 37). Similar deposits, usually containing a higher silty-clay content but often incorporating layers of sand or gravel were found infilling a valley at 0727 2270, of which no surface expression remained. The recent discovery by Ragg and Bibby (1966) of considerable thicknesses of periglacial material in the Broad Law area suggests that J. Rose's interpretation of this channel infill (pers comm.) as mainly solifluction material may very well be correct. Nonetheless, either the distribution of this material must vary considerably near the floor of the valley or meltwater channels of different ages must exist as several channels were found at relatively low levels with no vestige of such an infill, while others, as noted above, can only be observed in sections.

The other type of deposit not present elsewhere in the Tweed Valley is that observed in section at 0555 2082 and believed to compose the two mounds forming the riversedge extremities of parts of F 51 and 63. Along the main road from 057 213 at least as far as 055 206, particularly at the spot noted above, angular material up to 1.5 feet diameter, but usually much smaller, occurs to maximal observed depths of 5 feet. It is possible that in parts this may represent a frost-shattered residue overlying bedrock, concentrated in some areas by downslope movement. Equally, however, it may be morainic in character.

Very few ice-contact fluvioglacial deposits were found in this area. On the left bank of the Tweed, numerous meltwater channels exist, paralleling the overall downvalley direction and descending approximately to the level of the highest flats on the other side of the river. At the termination of the longest of these channels, the 0.5 mile Long Slake, at 0891 2385, and also at a similar location at 0921 2410, a few kames occur, probably related to late stage water flow along these channels.

Sections are scarce under all but the lowest terraces of this area. Bedrock exposed in the river bed at Tweedsmuir Bridge (0977 2435) was seen to approach within a few feet of the surface of some of the remnants in that area. Yet only 500 yards downvalley, the thick complex of drift described as section 26 in appendix 6 was noted. The steeply-inclined beds of sand and gravel which are truncated by the overlying quasi-horizontal boulder and sand and gravel beds, are best interpreted as ice-contact deposits, perhaps once existing within a kame. The overlying beds would seem to indicate a proglacial origin and, in view of the overall reduction in mean particle size upward, increasing distance from the ice front or diminishing discharge of the meltwaters. It is suspected that much of the upper 3 feet is related to deposition from the Bield Burn. An obvious fan debouches on to F 92 at Riverview (1003 2484).

Riverbank sections under the lowest fragments generally show sand or gravel. In several locations a peat layer is present under 2 to 4 feet of this sand and occasional gravel. Four samples from three different locations were taken and were analysed by Dr W.W. Newey. The pollen counts he obtained from samples taken at points 1 (0555 1797) and 3 (0549 1871) are listed in appendix 7. In the former case the sample was obtained from 2 feet above the river and an equal distance below the lowest fragment in that area,while the latter sample was taken in the middle of a peat band, 6 inches above rockhead, 2 feet above the Tweed and 2.5 feet below F 20. Although insufficient samples were gathered from any one location for accurate dating purposes, Dr. Newey was able to suggest that these organic deposits were formed in Pollen Zone VIII. This is based on the high proportion of non-arboreal pollen to the arboreal variety and supported by the presence of weeds, such as Plantago, Rumex and Umbelliferae. He states that the forest cover at the time cannot have been anything like complete and thus deforestation was in progress. What woodland was present consisted largely of alders, birches and hazel. Very strong local influence appears in both samples, the pollen count being affected by heathers (Ericaceae) and sphagnum, with sedges (Cyperaceae) and grasses (Gramineae). Thus these plant assemblages are characteristic of heath or blanket bog of Sub-Atlantic type.

D. Evidence for Buried Valleys in the Upper Tweed.

Apart from the lines of sections obtained by bores in the Talla and Fruid valleys (Chapter 4), no other evidence exists to indicate the depth of infill in the Upper Tweed valley or its tributaries, save where it is zero i.e. the rockhead is at the ground surface in the valley bottom. Sites where this was observed are 0825 2312 and Tweedsmuir Bridge in the Tweed and 0879 2288 in the Fruid Water valleys. Above the A 701 road, numerous small sections in tributary valleys show rockhead within a few feet of the surface and equally, similar exposures on the other side of the main river, as at 0751 2237, are not uncommon. Several bores drilled around 1307 3470 through the floodplain in the Drumelzier area for clay to act as puddle for the core of the Talla dam showed only that up to 6 feet of mossy clay overlies a minimum of 7 feet of sand and gravel.

Thus the evidence for buried sections of the Tweed Valley or its tributaries is totally insufficient for reliable interpretation. What evidence does exist, however, suggests a relatively thin infill but this infill may vary substantially. It is entirely possible, for example, that very thick deposits may line the floor of the Biggar Gap.

CHAPTER 8

THE PROJECTION PROBLEM

The fundamental assumption in heighting terrace fragments in any manner other than on a grid network or in a purely random fashion has already been discussed (Chapter 3). This is that in setting up single lines of heights down a terrace fragment, all are believed to be at significant locations and, as a corollary, to be representative of the surface to an acceptable degree of accuracy. If the representation error is not small, and it varies from fragment to fragment, this is likely to be an important source of error in the correlation of graphed points.

Miscorrelations are, however, probably more frequent owing to distortions from the projection plane utilised than to the representation error. In many ways the problem of representing heights of terrace fragments on graphs is identical to those encountered in the use of map projections. Distortions are inevitable and the form and magnitude of them must be appreciated before any interpretation of results is attempted. While many workers have, like Powers (1962), expressed some misgivings on the interpretation of graphed fragment heights on a simple height/distance diagram, the only other analysis of the problem known to the author is by Kirby (1966). It is believed that this account is rather more comprehensive than the latter. The distortions are best considered under two headings: those due to curvilinear and those due to linear projection planes.

A. Curvilinear Vertical Projection Planes.

Most floodplains parallel the downstream gradient of the stream responsible for them (Leopold, Wolman and Miller 1964 p.465). Thus they and other fluvial terraces are most conveniently represented graphically by projection into a plane following the course of this stream, minimising the distortions in representation of terrace heights, which were presumably collected parallel to and near to the stream course in the case of present-day terraces. This apparently simple solution leads to immediate difficulties. First of these, extremely important conceptually if less so in practice, is that in utilising a curvilinear plane following the course of a river, the issue of terrace origin is partly prejudged: only for meandering river-caused flats is this projection suitable. For such an origin to be assigned to a fragment in anticipation of projection of the heights requires either inspired intuition or the presence of appropriate primary surface rough -ness.

As well as requiring a prejudgement of the origin of the features, use of such a projection also demands an initial assessment of correlation, later to be accepted or repudiated by a series of tests, either visual or statistical. The assumed correlation of fragments is necessary in order to orientate the vertical projection plane. Yet the absurd requirement of a different projection plane for every terrace and, strictly, for every change of river course, in combination with the great amount of frontal erosion suffered by many terraces and the usual lack of evidence of the sinuosity or even pattern of the rivers responsible for them ensures that this projection form becomes not only optimistically accurate but also conceptually and pactically impossible.

A variant on this which is frequently employed is the curvilinear projection plane down the middle of a valley, following the valley course rather than that of the river. The not inconsiderable distortions associated with this form have often been ignored. Tomlinson (1925), for example, illustrated her paper on the terraces in the Lower Avon Valley by a height/distance diagram, the base line of which accords in length neither with the straight line nor with the river surface distance between Stratford and Tewkesbury. No indication is given of the layout of this single plane in plan view so it is impossible to know where the distortions occur and what their magnitude is likely to be. Except where steeply incised gorge sections of the valley exist, the location of such a plane must invariably be a compromise. If the valley is asymetrical in cross profile, the location of the vertical plane should shift as projection of the heights of successively higher terrace fragments is carried out. This problem is illustrated in figure 8.1, a hypothetical diagram. In cases where, say, high-level outwash is separated vertically from the present river by several terrace fragments, the vertical increments between these being less than 20 - 30 feet, the problem becomes very serious. Even where the outwash does not diverge from the main valley, as it appears to do in the Tweed Valley near Wrae Farm (Chapter 7), the projection distortions of such closely spaced terrace fragments could create one surface from several smaller distinct features or the reverse situation, depending on the orientation of the plane with respect to the fragments.

An extension of this problem is illustrated by figure 8.2. In the usual case of a valley asymetrical in cross profile in the region of meanders, not only is a different course for the mid-valley projection plane at higher levels necessary but such higher level planes will have a reduced sinuosity index, leading to appreciably different overall lengths for the projection base lines and thus considerable difficulty in comparison of low and high level features. The alternative is to ignore the often considerable variations in distance to the projection plane between left and right bank terrace fragments causing further differential distortions from projection into a curvilinear plane. A possible solution might be the use of a plane non-linear both in plan and in cross valley profile, thus maintaining its mid-valley position over any range of altitude. The more complex geometrical properties and problems of this type of projection plane were not examined.

A second major problem with this mid-valley plane, or indeed with any sinuous form, is the ambiguity of plotting positions that is possible, particularly where the valley is extremely sinuous or where the plane is some distance from terrace fragments. Figure 8.3 illustrates the point by taking the special case where the heighted point on a terrace is the centre of a sector of a circle whose circumference is partly followed by the vertical projection plane. In this case, there is an infinite number of points at which a line can be drawn from the plane to that point so as to be perpendicular to a tangent to the curve. Projection of heighted points along the front of a relatively straight-edged terrace fragment within a sinuous valley leads to a point distribution on the graph approximating to that of the trough centres of a longitudinal wave form where the pattern of the valley meanders in plan is sinusoidal. This is illustrated by figure 8.4, a section from a plot of heights from F 585 into a sinuous vertical plane following the river. The effect of alternately stretch -ing apart and compressing together the distances between spot heights is identical in form but greater in scale and thus more obvious in this case compared with that involving projection into a plane following the middle of the valley.

B. Linear Vertical Projection Planes.

The numerous distortions and disadvantages noted above, combined with the relative ease with which the type and degree of distortion of any one fragment's representation can be calculated when the linear vertical type of projection plane is employed, resulted in the exclusive use of the latter in the final plotting of terrace remnants in this study. Nearly 40 of these planes were found to be necessary and their distribution is shown in figure 8.5; the grid references of the intersections or the terminal points of the planes are included in the height/distance graphs, figures 9.1 to 9.23.

Like the curvilinear vertical projection plane, the linear one has inherent defects. Figure 8.6 illustrates the result of a continuous projection of floodplain or river surface height into such a plane, assuming a constant downstream gradient of both features. Rarely is a terrace so well preserved that this projected form will be obvious but it is possible that, in part at least, the sigmoidal profiles suggested possible by Frye and Leonard (1954) are due to a projection effect of this nature (figure 8.6b). By heighting a terrace in two lines, both parallel to the projection plane XY, one through and terminating at B and the other through and commencing at E, an apparent knickpoint can be produced in either river or terrace profile as shown in figure 8.6c. An apparent uphill section in a terrace profile due simply to projection effects is shown in figure 8.6d. While extremely simple, it is believed these and similar elementary geometrical relationships have been overlooked in some of the past literature.

Unlike projections into a sinuous plane, those onto vertical linear equivalents are not influenced by distance from the plane and no ambiguity of plotting position exists. As a linear plane is inevitably shorter than any sinuous plane for a given length of valley, the effect of the former is to reproduce correctly or to foreshorten the distance between any two adjacent heights on terraces. The curvilinear plane reproduces correctly, foreshortens or extends the projected terraces. The difference between the two types is shown by comparison of the total lengths of the linear projection planes between intersections and the river thalweg distance, the latter being 12 per cent greater than the former. Figure 8.7 illustrates that the reproduced equivalent of a distance AB on a terrace fragment when projected into a linear vertical plane is AB cos α, where α is the angle between AB or AB produced and the plane. Thus the amount of foreshortening of a unit distance AB in such a situation is equal to AB(1 - cos α).

The orientations and locations of the linear planes of projection shown in figure 8.5 were chosen subjectively to give what seemed reasonable approximations to the trend of approximately linear sections of the Tweed Valley. Two sources of distortion inherent in the use of this type of analysis are affected by the appropriateness of this subjective assessment. The first of these, concerning the effect on the gradient of fragments of revolving the projection plane about a vertical axis was brought up by K.M. Clayton in the Institute of British Geographers discussion in January 1967 on papers by Sissons, Cullingford and Smith (1966), a subject previously examined by Smith (1965). Identical problems are met with in terrace studies in that a projection plane markedly misorientated with reference to the majority of the terrace fragments would lead to unnecessary foreshortening and thus effectively increased gradients of the remnants. The effect of this on correlation is significant as visually it is much easier to distinguish between different gradient flats the lower are their reproduced gradients.

The second source of distortion and resultant miscorrelation affected by the subjective placing of linear projection planes is the effect of an inappropriately sited plane being adjacent to a suitably sited one. Figure 8.8 represents the situation when terrace fragments existing on the inside of the intersection of two planes are projected into these planes. A zone of overlap is seen to exist in that both A and B appear on both planes. Yet C, a spot on a higher terrace, is vertically above A on projection plane Y while D is vertically above it on plane X. A similar change of relative position of D occurs between the two reproductions. The projection of remnant heights from the outside of the intersection of the two planes gives an identical shift in the reproduced positions except in an opposite direction to that shown in this diagram. Considerable complexities are thus possible in the vicinity of the junction of two planes where projection is necessary from both sides. The position is further complicated if one of the planes is inappropriately orientated, thereby causing not only a change of reproduced relative positions of terrace fragments near the junction of two planes but also abrupt changes in gradient in any one continuous feature at this point due to foreshortening by the incorrectly aligned plane.

To reduce the effects of these distortions, additional projection planes were plotted, some bisecting the angle between adjacent planes and others perpendicular to this direction. The relationship between tributary valley forms and those of the Tweed Valley were investigated in the same way. As the distortions at the ends of adjacent projection planes could not be studied if these were joined together, each plane is reproduced individually except where the angle between the two planes is so shallow as to cause minimal distortion or where few terrace remnants occur in the vicinity of the intersection of the planes. An initial assumption that correlatable fragments should have similar gradients was necessarily relaxed in some cases when correlating between projection planes.

CHAPTER 9.

STATISTICAL AND NON-STATISTICAL DATA MANIPULATION AND NORMATIVE CONCLUSIONS.

There is no more common error than to assume that, because prolonged and accurate mathematical calculations have been made, the application of the result to some fact of nature is absolutely certain.

A.N. Whitehead, quoted in Moroney (1956 p.271)

Data analysis cannot do more than bring to our attention a combination of the content of the data with knowledge and insight about its background. Validity and objectivity in data analysis are dangerous myths.

J.W. Tukey, quoted in James (1967 p. 30)

A. Correlation and Origin Derivation Procedure.

The procedure employed in correlating terrace fragments, where this was possible, essentially consisted of visual inspection of the projected profiles and a qualified subjective assessment of which fragments were associated remnants of a once-whole terrace. Only where a considerable number of fragments of varying gradient were present was it found possible to relax the stringent pre-condition that fragments should have comparable gradients. A mean value for the downvalley gradient was employed in the assessment of terrace fragment origin using the classification outlined in Chapter 1.

In detail, the means by which fragments were correlated was as follows:

1). Best-fit lines were drawn by eye through terrace fragment heights represented on the linear projection planes (figures 9.1 to 9.23), neglecting those fragments which consisted of a large scatter of heights (e.g. F 794) or those which were clearly some kind of complex form, due either to several agents or incorrect assumption of downvalley direction in heighting. A minimum of 7 points was normally required on a terrace fragment before accepting that a best-fit line could significantly represent the gradient (section D) although this was relaxed slightly where 5 or 6 heights were seen to exist along a straight line, often part of a present floodplain.

Even where the gradients of heighted features were not used in this analysis for the above reasons, the raw data are still of value in that the absolute position of some part of their surface may coincide with a line between two correlated fragments.

2). Where the above procedure was possible, being based on more than the minimal number of heighted points which showed little scatter, the best-fit lines were projected short distances up and down valley and compared with other similar lines. If a good relationship seemed to exist between fragments separated by up to 3 - 400 yards at a maximum, making what seemed a reasonable allowance for a downvalley diminution in gradient if necessary, these fragments were considered to be correlated and a mean line drawn between them. Considerable care was exercised wherever such correlations, except of patently obvious presentday floodplains, might occur across the junctions of projection planes. This was necessary owing to the inherent distortions (Chapter 8), and other planes were usually plotted to further test the correlations. The limits to cross valley correlation specified in section E of this Chapter were applied wherever relevant. In all examinations of terrace long profiles and in attempts at cross valley correlation, the impossibility of distinguishing separate stages represented by similar gradient terrace fragments or their projections separated vertically by an amount less than the front to back height variation on either flat (Chapter 3) had to be borne in mind.

3). Any correlations made, in common with any interpretations of origin deduced from use of the interpretive classification used, were then tested by comparison with all other available non-altimetric evidence. If no agreement was found, re-examination of both types of evidence was carried out; in a few cases, this led to the abandonment of postulated correlations between two or more fragments.

4). The ultimate level of abstraction from reality entered into was the reduction of all the positions and gradients of the reproducible fragments, correlated where possible, to form figure 9.35. This summary diagram of what is believed to be the terrace 'sequence' in the Tweed Valley is made up of 29 combined linear projection planes: where the reproduced heights of one terrace fragment on two successive planes are far enough apart to imply misleading correlations should only one of them be reproduced, both have been inserted. Numbering of the terrace fragments and terraces was restricted as such figures detract from the overall impression of the terrace sequence. Unnumbered fragments can be identified by reference to the relevant individual height/distance diagram.

B. A Justification of Terrace Long Profile Correlation by Visual Inspection.

The repeatability and objectivity which Merriam (1966) alleged to be the prime benefits of quantification are not invariably achieved in terrace correlation by visual inspection. Yet the basis of the correlation of the fragments in this study, supposedly dedicated in part to a more detailed and objective scanning of the means of terrace correlation, is simple visual inspection. It is recognised that this is not an entirely satisfactory means of correlation: it was employed only because benefits attributable to the use of more sophisticated techniques on the form of data available are illusory. A different technique for terrace remnant correlation, based on the collection of data on an areal basis over a small number of terrace fragments, is discussed in Chapter 11. To extend this to the terraces of a whole river valley requires both more experiments to test the widespread validity of the technique and also a more rapid means of acquiring accurate altimetric data - perhaps the Neilson Continuous Slope Profile Delineator described in Chapter 3.

Any simultaneous optimisation of a series of correlation coefficients for terrace fragments throughout a valley is impossible as this involves a pre-judgement of the terrace long profile forms. Statistical correlation on a non-areal basis is thus only possible in a step by step fashion: comparing fragment A with fragment B and, if this is a good fit, fragment B with C, then A with C, and A and B combined with C, etc. At least two possible variations exist on the usual method for making this statistical comparison: the first is simply to fit a linear or perhaps a curvilinear regression line through both fragments and specify a value for r, the correlation coefficient, below which any relationship will be rejected as not demonstrated. More objectively, the r value could be compared with the equivalent values for each separate fragment to test whether any significant difference existed between them. Selection of the degree of the estimating equation used will be governed by the initial assumption of the long profile form of the terrace over short downvalley distances.

Alternatively, a different method could involve testing the gradients of two fragments, through which regression lines yielding high r values have been fitted, by viewing these as sample means derived from a random population. Use of a t test would show if these significantly differed and if this proved not to be the case, a similar test could be employed involving the mean height difference between the two fragments and a value K given by:

K = distance between mean height of each of two best-fit lines fitted to the lengths of each terrace fragment x the mean gradient of these best-fit lines.

Thus both the elements of correlation shown in figure 2.2, comparable gradients and also comparable projected intercepts, are tested by this method.

Approximately 800 terrace fragments were heighted in this study, involving the acquisition of nearly 11,000 spot levels. The computing time necessary to step-by-step correlate all these fragments would be very considerable, particularly as a change over from linear to curvilinear regression forms would be necessary as expansion of the correlation outwards from the initial two fragments proceeded. Approximately 5^{200} calculations would be involved. Nonetheless it was the low returns payable rather than the volume of work involved that determined that this course should not be followed.

Correlation coefficients are functions of the values and amount of the input data. The problems associated with projection of terrace fragment heights onto a vertical linear projection plane outlined in Chapter 8 ensure that unless the abstracted values for the horizontal (distance) scale are manipulated before calculation, the correlations, particularly in the areas around the intersection of planes, will be as much a function of the projection as of reality and the data collection system. Mean values for gradient are thus also partly a function of the projection plane orientation with respect to the heighted points layout. Variations in the number of points on one fragment with reference to another will also be an important inbuilt weighting of the gradient and intercept values for regression lines fitted to combinations of two or more fragment long profiles. A good argument can thus be made out for collecting, or at least analysing, similar numbers of heights for each remnant. Indeed, to counteract the moment of heights on long terrace fragments, more heights should perhaps be taken on smaller fragments than on large ones. In practice this is unsound as large fragments are much more reliable indicators of gradient (and thus origin) than small, often dissected features.

By default, therefore, rather than by any positive virtue save that of a relatively low degree of effort involved, visual inspection was used in place of any statistical tests for correlating the fragments. Nonetheless, statistical techniques were found to be useful in descriptive rather than correlative procedures involving terrace fragment gradient and position. The results and implications of these tests are discussed in section D.

<u>C. General Observations on Terrace and Terrace Fragment Long Profiles.</u>

In general, the height/distance graphs of terrace fragment altitudes against location illustrate all the theoretical distortions noted in Chapter 8. Marked foreshortening of terraces close to a section of the river flowing obliquely with reference to the projection plane has occurred in the representation of, amoung others, F 586 on figure 9.19. On the same diagram, the incomplete record of river surface heights, combined with the distortions due to the projection erroneously suggest to superficial examination that some fragments, such as F 588, are related to a knickpoint or nickpoint in the river profile.

Many of the lowest terrace fragments are both consistent in downvalley gradient (e.g. F. 203 on figure 9. 7) and are closely comparable in height with other like features immediately across valley. Thus F 398 on figure 9. 15 appears to be identical with F 385. However, many other such features show considerable variations, as in the complex of low terrace remnants shown on figures 9.2 and 9.21. In such cases, cross valley correlation is rendered highly complex and problematical. That such low level features, most of which show every indication of being relatively recently formed, should show variations commonly up to 5 feet or more in height over short distances and that numerous fragments should exist over small vertical ranges suggests that considerable possibilities exist of miscorrelating higher, older and more dissected features. Thus lines joining two non-contiguous fragments could easily be significant -ly diachronous, even making allowance for the rapid short term changes believed to be possible in the formation of these features (Chapter 2).

It is likely that many of these height variations are due to the incidence of small tributary fans on to or the incision of now-partly infilled channels into the terrace fragment. Particularly where the field assistants had not acquired a high degree of skill in distinguishing these, minor mistakes are probably unavoidable.

Nonetheless, it is also likely that much of the irregularity of relief found on the low terrace remnants is due to traversing across remnants of primary roughness. Traverses across floodplains made up of point-bars and intervening depressions could be expected to produce sinusoidal wave-like surface height patterns. Alternatively, some of the upward-convex elements of supposed-floodplain relief could be the sawtooth-like remains of higher gradient terraces disappearing beneath the later, low angle features.

One aspect of great importance concerning low terraces is illustrat -ed by the plot of F 816 on figure 9.23. Here a low terrace remnant, clearly related to the present River Whiteadder, is seen, when projected on to the main projection plane in this area, to be much steeper and also falls considerably below the lowest comparable feature on the south bank of the Tweed. This emphasises that if what are believed to be present-day or near-present-day features in the vicinity of river junct-ions cannot be correlated, spurious correlation of older fragments in similar areas is all too easy.

Several higher terrace remnants have negative, complex or irregular gradients as reproduced in these diagrams. Examples of this include F 428, 379, 736, 738 and 794. Some of them, like many apparently anomalous low terraces, owe their misleading projected form to projection distortions but probably more of them are the remnants of fans emanating from tributary valleys (e.g. F 238, 282 and 833). Indeed, some of the high gradient terrace fragments are also formed of the down (main) stream sections of now eroded tributary valley fans or their present day equivalents (e.g. F 207 on figure 9.7). Where these have been identified, as in the case of part of F 342 on 9.12, they have been inserted on the maps as such; in the respect that they represent both the results of field mapping and terrace surveying rather than the former alone, these maps differ from the original 'field' equivalents.

Some higher fragments are too complex to be dealt with by simple altimetric means. F 403, for example, could be due to an infinite number of combinations of processes. Likewise F 794 appears to defy explanation except that this large flat, already discussed in Chapter 5, may have been heighted inappropriately. It emerges from between drumlins and is composed partly of ice-moulded, low amplitude relief protruding through what apparently is often a flat topped sheet of sand and silts. If the water courses were confined to the interdrumlin areas and this sheet were deposited proglacially its detailed form in the area adjacent to the ice sheet and/or the drumlins could be expected to be a complex of alluvial fans. While the results derived from a simple height layout employed did not accord with this hypothesis, suggesting that the flat is more in the nature of a till plain, this is by no means proof of its non-fluvial nature. Indeed such an explanation provokes the need for a further explanation for the sudden disappearance of substantial ice-moulded forms.

The hooked or reflexed ends observable on some higher terrace fragment plots, occasionally occurring even where a series of heights falls evenly for some distance, is probably due to commencing or continuing heighting slightly off the flat. As the working definition of these features employed throughout this study included their nature as near-laminar surfaces, the gentle flexuring between these and low gradient backing hillslopes was often difficult to pick out accurately. Several small terraces certainly owe their negative or complex gradients to human modification, such as in the case of F 428, the terrasiform deposits underlying which have already been described (Chapter 6). Other small features such as F 802 may be composite, consisting perhaps of a terrace section proper and the surface expression of mass movement materials where, as in this case, a rapid change of gradient occurs in a distance of 2 - 300 yards.

Certain negative gradient flats defy all the explanations provided to date. Those in the mouth of the River Till, particularly the lower remnants F 775 and 777 rise downvalley towards the Tweed. The most likely explanation in this case is that although probably underlain by deposits largely built up by the Till, the surface expression of these landscape elements reflects periodic overbank deposition from the Tweed, greatest in volume near that river.

One of the most puzzling long profile forms is that exhibited by F 821 and certain other fragments. An upwardly concave profile is explicable either in terms of miscorrelation of two different gradient forms or by addition of material differentially to an already existing feature. Upwardly convex forms such as F 821, however, seem to demand either mid-point addition of material, highly improbable in most of the cases concerned, or differential erosion of the up or downstream sections if they are not to be regarded as primary features. Alternatively, some may result from heighting at different locations with reference to the original down-valley orientation of the outwash surface (if such it is) where the cross valley gradient is large and the downvalley equivalent is small by comparison. In this way, heighting along the edge rather than along a line parallel to the main valley side at this height could give misleading impressions of gradient where the edge is not parallel or sub-parallel to valley sides or centre over distances of 3 - 400 yards or more. This explanation does not fit by any means all of the flats displaying this type of long profile.

The very high percentage of non-simple positive forms explicable by combinations of projection and post-formational effects and small permissible errors in field work, combined with a total lack of any convincing alternative evidence of subglacial accumulation of laminar-surfaced deposits, resulted in the final virtual elimination of this category of terrace origin. It is possible, for example, that the esker at Hallyne (Chapter 7) is partly buried beneath the terrasiform deposits underlying F 222, as may be the Sheriffmuir esker some 1.3 miles to the southwest, or it may be a residual of a higher flat, although this seems unlikely. Nonetheless, in view of this widespread lack of evidence it seems folly to invoke subglacial sedimentation for occasional flats when they are surrounded by other terrace features which have present day proglacial counterparts in many parts of the subarctic world.

Likewise, based on the combination of morphological mapping and altimetric evidence, no proof was found of the existence of lacustrine terraces within the field area. Combinations of morphological, altimetric and lithological evidence, where these existed in close proximity, showed that some ice-proximal outwash had positive surface gradients of as low as 35 feet per mile (e.g. F 571) in some areas. In the extreme Upper Tweed Valley, however, the river surface and floodplain gradients are of this order and occasionally exceed it. Thus the minimal figure of 50 feet per mile initially set for assignation of an ice-proximal outwash origin to terraces and terrace fragments on the basis of their gradients is seen to be a reasonable one for most of the valley. It can not be said, however, that terrace fragments with gradients less than this value are definitely not the surface expression of ice-proximal outwash, except where stratigraphic or other morphological evidence confirms this interpretation.

Despite the evidence of the recent work by Ragg and Bibby (1966) which suggested the widespread distribution of periglacial phenomena in the higher ground of the Upper Tweed basin, only limited evidence of such phenomena in proximity to the terraces was found. This, in combination with the height data which enabled fluvial origins to be assigned to terrace fragments in this area, led to the apparent redundancy of the solifluction categories in the interpretive classification in this case. This does not deny the role such deposits may have had in contributing to the build-up of now-terrasiform deposits in some parts of the valley.

In some cases, downvalley correlation of terrace fragments was easy and satisfactory. Indeed, combined cross and down valley correlation was carried out in several instances, notably between F 795b and 738 in figure 9.22 and between F 585 and 584 in figure 9.19. More frequently, both were impossible owing to the distance between terrace fragments compared with their individual lengths and the height variation upon them. Nonetheless, accepting the gradients of large fragments as significant representatives of the original features and grouping the remnants into suites, a sequence of events can be elucidated. This is elaborated in Chapter 10 but it is important at this point to note that the end result portrayed in figure 9.35, whatever allowance is made for projection effects and other distortion-causes, is not the 3 or 4 river-long, sub-parallel or nickpoint-related terraces widely reported from elsewhere. Rather is it a complex of distinct suites of moderate to high gradient terraces, probably due to ice-proximal outwash, truncated by the distal sections of later valley trains and near-present day river terraces. It may be that in containing such a sequence the Tweed Valley is unique in Britain, but this seems unlikely.

D. The Repeatability of Terrace Long Profile Results.

Two aspects of the repeatability of values obtained for terrace fragment gradients were investigated by taking a sample of 62 from the approximate total of 800 remnants. These were the effect of heighting at progressively greater distances apart and also the effect of heighting in different parts of the flat at the same distance apart on the resultant downvalley profile. Most of the basic height data was obtained, as already discussed in Chapter 3, at distances apart of 50 yards or less. Tests of the effects of different data distribution patterns are reported in Chapter 11.

Two indicators of the variation in accuracy with change of other parameters were used. These were percentage variation and actual variation of the terrace gradient, B and the projected terrace intercept value, A where a line fitted to the projected fragment heights was of the form:

$$Y = BX + A$$

X and Y are the Cartesian coordinates of any point on this 'best-fit' line. The percentage variation, L was calculated from the expression

$$L_A = \left| 100 \times (A_n - A_1)/ A_1 \right|$$

$$L_B = \left| 100 \times (B_n - B_1)/ B_1 \right|$$

while the actual variation, M, was calculated by

$$M_A = \left| A_1 - A_n \right|$$

$$M_B = \left| B_1 - B_n \right|$$

where A_n is the nth value of the projected fragments intercept and B_n is the corresponding value of its gradient. The vertical slashes indicate that the modulus of the contained value was taken.

The values of L and M, together with r, the correlation coefficient, and the standard error of estimate for each best fit-line and sundry other values were calculated by a series of variants on an Atlas Autocode program entitled CORREG. The eleventh version of this is set out in appendix 8 as an example; far from being the most efficient possible program for computing these values,it is however, simply understood and modified. The table set out below outlines the basis of the calculations performed by this and CORREG 14.

Heighted Points.

1 2 3 4 5 6 7

a) CORREG 11

Sequence of operation:

1) Computes A_1, B_1, r_1, etc. for all heighted points. N = 7
2) Computes A_2, B_2, r_2, etc. for points 1,3,5,7. N = 4
3) Computes A_3, B_3, r_3, etc. for points 1,4,7,. N = 3
4) Computes A_4, B_4, r_4, etc. for points 1,5. N = 2
5) Computes A_5, B_5, r_5, etc. for points 1,6. N = 2

From these values, percentage and absolute changes in the A and B values are calculated as already outlined. N is the number of terms involved in the calculation.

b) CORREG 14

Sequence of operation:

1) Computes A_{2_1}, B_{2_1}, etc. from points 1,3,5,7, $N_{2_1} = 4$

2) Computes A_{2_2}, B_{2_2}, etc. from points 2,4,6, $N_{2_2} = 3$

3) Computes A_{5_1}, B_{5_1}, etc. from points 1,5, $N_{5_1} = 2$

4) Computes A_{5_2}, B_{5_2}, etc. from points 2,6, $N_{5_2} = 2$

5) Computes A_{5_3}, B_{5_3}, etc. from points 3,7, $N_{5_3} = 2$

6) Cannot compute A_{5_4}, B_{5_4}, etc. as $N_{5_4} = 1$

7) Cannot compute A_{5_5}, B_{5_5}, etc. as $N_{5_5} = 1$

In the first case, the changes in values with increasing distance apart were calculated by stepping, such that for the results pertaining to heighting at 100 yard-intervals on any one terrace, the first, third, fifth, etc., of 50 yard-apart heights were employed. This was carried out repeatedly until the required values were obtained for heighting at 100, 150, 200 and 250 yard intervals and all compared with the 50 yard-interval values for all the 62 fragments used. Fault traps were built into the program to cover the eventuality when only one heighted point was available after carrying out the above operation. While the adopted convention in CORREG 11 was always to commence with the first height on a terrace fragment, CORREG 14 calculated the A, B, r and other values at 100 and 250 yard intervals where heighting was assumed to commence on the first point, then assuming commencement on the second point, etc. From these results, percentage and actual variations of A and B were again calculated.

Figure 9.24 illustrates the variation of the actual difference in gradient, as represented by $|B_{2_1} - B_{2_2}|$ with respect to N_{2_1} where B_{2_1} is the gradient value for 'best-fit' lines fitted to any fragment compiled from the 100 yards apart values commencing at height 1, while B_{2_2} is the equivalent value commencing at height 2. N_{2_1} is the number of points involved in the calculation, taken for convenience from the case where calculations employ the first, third, etc., 50 yard-interval heights. A good logarithmic relationship with a moderately high value for r of 0.7842 was obtained by fitting a regression line of the form log Y = log A + B log X, where N_{2_1} was assumed to be the independent variable. In this, as in all the relationships described in this section, all the correlations and regressions are significant at the 95% confidence level. As one unit variation in B represents a change in gradient of 3 feet per mile, it seems advisable only to height fragments at intervals of 100 yards if it is possible to get more than 5 - 7 spot heights on the surface in the fixed interval linear mode. If fewer heights than this are obtained, samples of gradient values for the same terrace may vary by 4 feet per mile or more. Under conditions similar to those in the Tweed Valley, this graph could be employed to suggest the minimal number of heighted points required to provide a given consistency.

A similar relationship is shown in figure 9.25, a graph of actual intercept variations between 'best-fit' lines fitted to 100 yard-apart height values on the same terrace against the number of heights. In this case, however, a steeper gradient and a larger scatter of points is evident, probably because the A value is in part a function of B, but is also partly independent. Figure 9.26 is identical to figure 9.24 except that it portrays the differences between the maximal and minimal gradients of 'best-fit' lines fitted to heighted points some 250 yards apart on a terrace in comparison with the number of heighted points. Thus in the manner illustrated above, CORREG 14 computed B_{5_1} to B_{5_5}, then printed out $B_{5_{max}}$ - $B_{5_{min}}$, which was graphed against N_{5_1}. A logarithmic relationship similar to those already observed, showing increasing variation in results with decreasing number of heighted points is evident.

Figure 9.27 illustrates the change in accuracy of representation of a fragment by selecting different locations for the surface heights in another manner. Here the modulus of the percentage variations in B, the gradient of the fragment, is graphed against N for all distances apart in excess of 50 yards. The succeeding figure, 9.28, illustrates this relationship when restricted solely to variations between the two possible gradient values based on 100 yard-interval heights, selected from the basic 50 yard-interval data. In both cases, although a considerable scatter of points is evident, the likely variation in representation of a fragment's gradient by taking repeat -ed samples is unlikely to be greater than 10% if N is 10 or more; a value for the latter of 7 or 8 will probably give results of tolerable accuracy in virtually all cases. The extreme values for percentage variation in gradient are obtained from those samples where B_1 is very small (see the equations set out above).

The percentage variation of the gradient of a fragment graphed against the distance apart at which it is heighted is illustrated for all heighting intervals in excess of 50 yards in figure 9.29. While the percentage variation does seem to increase slightly with increasing height interval, the very large scatter of points about the mean for each heighting interval suggests that this is merely a reflection of the decrease in N with increasing distance apart of each height for any given terrace.

There is no reason whatever to suspect that had heights also been available at 25 yard intervals, the variations in gradient of the terraces from heights at 50 yard intervals would have been in any way different to those obtained from the 100, 150, 200 and 250 yard-interval heights. On this basis it is reasonable to draw the following conclusions from these results. Variations in percentage and actual gradients and, largely by analogy, in percentage and actual intercept values of 'best-fit' lines calculated for terrace fragment heights which are collected from different positions and different intervals apart, are generally quite small. While the actual number of heights necessary on any one fragment varies with the accuracy and repeatability it is considered necessary to achieve, it seems that, in Tweed Valley-like conditions, 7 or 8 heights on a flat give an acceptable estimate of gradient within the area from which they are taken. Flats represented by heights fewer in number than this threshold may be correctly reproduced but this cannot be relied upon as the consistency is below an acceptable level. Even where terrace gradient cannot be represented adequately by heights obtained, it is unlikely that all parts of the surface have been substantially modified since the creation of the terrace. Therefore the height values in such a case may still be useful in adding confidence to correlations where projected 'best-fit' lines from two terraces, one up and the other downvalley from the modified fragment, pass through some part of it.

No good relationship was observed between variations in terrace gradient with increasing interval of heighting. The poor relationship observed is believed to reflect the partly co-variable nature of N and distance apart of heighting. Most terrace fragment heights showed relatively small scatter about a 'best-fit' line; the plot of r, the correlation coefficient derived from 50 yard-interval heights, against

N_1, shows that the former is not a sensitive enough indicator of reliable and unreliable terrace gradient values (figure 9.30).

E. Cross Valley Correlation of Terrace Fragments.

Two methods of statistical correlation of the long profiles of terrace fragments have already been suggested even if applicable only under limited conditions and involving certain assumptions such as the long profile form of terraces over specified distances. Equally, t tests could be made on the mean values of the cross profile heights of two fragments to see if they were significantly different. What these statistical tests neglect to allow for, if used in their standard form, is the vital relaxation in the stringency of the requirements for one flat to be considered correlatable with another with increasing dissection of the fragments. The smaller the undissected remnants become, the larger must be the 'classes' into which the succession can be split.

As was pointed out in Chapter 1, this is not universally true because some surfaces, particularly those due to fluvial agencies, probably have an ease of characterisation curve of the form illustrated in figure 9.31, varying in detail with variations in climate and other factors. The relative ease of characterisation possible a certain time after the formation of a fragment does not necessarily establish a high degree of significance. Bearing this in mind, what is required is a formula from which a minimal height range is provided to suit a variety of environments such that, if two terrace fragments fall within this band, they cannot be subdivided. Conversely if they fall outside the band, they cannot be shown to be paired features.

It was noted in Chapter 2 that such a formula might be based on a comparison of the mean difference in height of the two surfaces with some aspect of the height variations on one or another or both of the flats. This could be represented as:

$$\text{if } MD \leqslant \frac{MX_1 + MX_2}{2}, \text{ then the fragments cannot be}$$

regarded as unpaired. MD represents the mean difference in height between the two surfaces along a given cross profile while MX_1 and MX_2 are the maximal height variations on the two surfaces. It is probably necessary to include a factor D on the right hand side of the inequality to increase the value of the height range where the distance between the two lines of height, a partial function of D, is such that correlation necessarily becomes more imprecise. Apart from this the formula is virtually self-regulating in that the older are a pair of fragments and presumably the more dissected they have become, once past the point A on figure 9.31, then the greater is the vertical range within which the two flats can lie and still be considered to be not unpaired on the available evidence.

Clearly, multiples of one side or other of the equation can be introduced as necessary conditions if it is desired to make the conditions for pairing more stringent or more relaxed. The only means in which the validity of this empirical method of defining cross valley correlations can be accepted as reasonable is by investigating the altitudes of two fragments known to be contemporaneous and formed by the same agent. Due to a lack of datable materials in the near-surface terrasiform deposits in the field area, the only features which can reasonably be assumed to satisfy these requirements are relatively low gradient, near-river level terraces, the so-called floodplains. If these are not paired in the present environment it is unlikely that much reliance can be placed on pairings of much dissected higher features.

A study of the lowest remnants illustrated on the long profile diagrams revealed that in most cases the variation in height between those on opposite sides of the river did not exceed 3 feet, at the positions heighted. Examples of this can be seen in figures 9.4 9.8 and 9. 11 Non-systematic height variations on these features taken individually are often up to 5 feet, usually composed in the main of a component of the often systematic front to back height variation. Thus, in this case, where no account was taken of variations in D, the method produced the acceptable answer that these land forms, some of which at least are believed to be in the process of formation or active modification at the present time are paired features, or rather that they cannot be shown to be unpaired. As no higher fragments could be correlated across valley on non-altimetric grounds, it was strictly impossible to establish empirically any range of multiples for either side of the postulated inequality to vary the stringency of the test for certain conditions.

F. The Long Profile of the Present River Tweed.

The peculiar form of the long profile of the present river Tweed surface is shown in arithmetric graphical form in figure 9.32, drawn from the levelled spot heights of the summer (normal) water level which are tabulated in appendix 1(c). For nearly 50 miles the middle section of this river is virtually linear while, further up valley, an equally good if steeper gradient linear relationship can be derived from the section about 8 miles long below the Cor Water and Tweed junction. A plot of the same data on logarithmic graph paper (figure 9.33) was in many respects less satisfactory despite the fact that this is a commonly used and often apparently successful technique for fitting logarithmic curves to river long profiles (Chorley 1958).

Throughout the river's course there appears to be no immediate correlation between bedrock type or tributary incidence and river surface gradient, except that the second major diminution in gradient begins near Fleurs Castle, coinciding approximately with the near-surface existence of Lower Carboniferous limestones and sandstones. While it is hardly surprising that the river gradient should be independent of bedrock stratigraphy in areas where it runs on a deep sand and gravel infill, it is a little perplexing that no large scale variation in long profile form occurs at those locations where rock outcrops have already been noted to pierce the drift. The gradients of the water surface of all the tributaries measured except one, the Biggar Water, were steeper than adjacent sections of the Tweed surface.

G. An Analysis of Seismic Wave Velocities.

It is a reasonable hypothesis that seismic velocities of similar components of identical wave types travelling through bedrock of a given type should be fairly constant. To a lesser extent the same applies to till and to sand and gravel although the more heterogeneous the particle size and the looser the packing, the less is the influence of bedrock type and the more the effect of ground water becomes important in modifying the velocity of seismic waves.

In figure 9.34, a) is a histogram of the number of meaned velocities plotted within 1000 feet per second class intervals obtained from the forward and reverse traverses (tabulated as appendix 4), traverses in opposing directions being necessary in order to over-come the effects of sloping interfaces relative to the ground surface. The peaks in the low velocity ranges up to 3000 feet per second in

a) and also in b), c), and d), which are breakdowns of the values in a) into stratigraphic groupings, indubitably reflect the presence of sand and gravel. It is possible, however, that parts of this may be due to values obtained on a highly weathered till, perhaps of the ablation variety.

The higher velocity groupings provide a puzzling situation, not simplified when it is appreciated that till on one lithology could have very similar velocity characteristics to bedrock at another site. Where tills are bouldery, however, a fair scatter of points about the 'best-fit' line should indicate its presence unambiguously. In view of the sandstone nature of much of the Carboniferous strata in the Tweed Basin, those velocities in excess of 7000 feet per second found when working over these or Old Red Sandstone rocks are provision -ally assigned to bedrock. The one value in the former group in excess of 12,000 feet per second obtained at Fleurs Castle is probably due to the basaltic lavas interdigitated with the Lower Carboniferous sediments of that area (Chapters 4 and 5). Values intervening between the bedrock and sand and gravel ranges are provisionally interpreted as till. The tri-modal distribution of seismic velocities on Silurian and Ordovician rocks may represent sand and gravel, till and bedrock; however, the near complete lack of borehole control in this area renders this no greater status than that of a hypothesis.

CHAPTER 10

THE SEQUENCE OF EVENTS IN THE DEGLACIERISATION OF THE TWEED VALLEY

Given the evidence presented in Chapters 4 to 9, it is possible to compile a less fragmentary account of deglacierisation within the Tweed Valley than has previously been available. One important qualification must be made concerning this, however, and it is that the evidence is constricted, traverse-like, to areas adjacent to the river. Only Price's (1961) study of meltwater channels and associated deposits plus work in progress by Sissons is on an areal basis. Until the latter work at least is complete, the regional significance of the Lower Tweed Valley terrace scheme can not be considered as positively established. For example, the contribution which waters channelled in now near-dry valleys, such as that of the Eden Water, made to the terrace sequence further down-valley can not be directly evaluated as, in many cases, very few terraces emanate directly from these valleys.

Certain fundamental concepts must be stated to avoid their repetition at every stage in the following discussion. Most important of these is the means by which it is believed the ice disappeared. No indisputable evidence of late-stage active ice in the form of moraines or rotating striae and drumlins were found. Similarily, evidence for stagnation is absent except on a local scale. Indeed in certain parts of the lower valley, away from the Tweed itself, no evidence of meltwaters can be traced, almost as if the ice had been lifted from the drumlins en bloc. Due to the unrestricted downvalley passage for meltwaters, stagnation may have been restricted in most cases to the very last stages of ice decay in enclosed rock basins or inter-drumlin hollows. The variation in valley cross profile must have considerably affected the pattern of deglacierisation and in the light of this, the following is proposed. In the Merse, ice disappearance was accomplished by downwasting, the ice becoming stagnant only around the margins of nunataks and at the extreme ice front while the upper layers, perhaps to a depth of 200 feet or more became decayed and permitted the easy passage of meltwaters. This pattern seems to have continued as the ice 'receded' into the middle and upper valley although modified in that in the centre of the troughs, ice probably remained active almost throughout the deglacierisation, the margins becoming stagnant or near-stagnant much earlier. The width of the stagnant ice front probably varied with the form of the valley cross section.

It will be demonstrated later that the logical result of the southwesterly source of much of the ice in the Tweed Basin was that, particularly in the higher reaches of the valley, ice in north and northeast-trending valleys was probably active and existed longer than in nearby valleys orientated in other directions. South-draining valleys such as the Eddleston and Leithen Waters contained ice which became decayed first. The break-down of the early-stage northeastward drainage from these areas demonstrated by Price (1961) may have been a quite rapid reversal of drainage to the present and pre-existing lines. These variations in the date of ice melting seem to have been related to distance to the ice-dispersal centres, variations in solar insolation intensity and also the bedrock topography, in so far as it controlled the large scale dispersal of meltwaters.

The course of the present Tweed, initiated or re-initiated by these glacial meltwaters, seems to follow the lowest till surface, except around Makerstoun Gorge. This may be a reflection of the course of a pre-existing rockhead valley, modified by glacial erosion. That the trend of the drumlins below Coldstream is askew to the present Tweed reflects only the anti-clockwise rotation of ice in the area on to slightly higher land (figure 4.8 and Chapter 4). Meltwaters from the Tweed glacier possibly escaped at early stages not only down the present course of the river or parallel to it but also to the south-east via the Aller Dean (980 475) and similar, now-dry channels cutting the Fell Sandstone Ridge.

In detail, the earliest evidence of glacial meltwaters known is probably the sands encased between the part-laminated clays and the overlying till near Berwick, shown in section I. The sequence of events purported to be responsible for these fluvioglacial deposits has already been discussed (Chapter 4) and may involve the presence of foreign ice. As well as several poor sections in the Horncliffe - Gainslaw Hill area which in some cases show what appears to be till overlying fluvioglacial sediments, further early stage deglaciation phenomena may be the higher level meltwater systems, the Longridge meltwater channel (probably sub-marginal) and the Lamberton Moor complex in the eastern Lammermuirs (figure 10.1).

The terraces and terrace fragments (figure 9.35) constitute the next known evidence of the deglacierisation pattern in the area studied. Taking the section from Coldstream to Berwick as one unit because the high gradient terrace fragments exist only rarely upvalley from the former location, the number of highly inclined features is sufficient to suggest that these represent outwash or erosion of pre-existing materials by meltwaters from an ice front effectively retreating up the Tweed Valley. Apart from the sporadic kames at Mount Pleasant and elsewhere, related to ice front stagnation, little other evidence is available on which to base postulates of ice-withdrawal mechanisms. It seems extremely likely, as much from the lack of evidence of other mechanisms as from positive evidence, that in this area a broad, valley-wide ice mass, slowly downwasting and thus 'retreating', gave rise to meltwaters which at late stages were concentrated in the locally-lowest section of the valley and in which they alternately eroded and deposited. Figure 10.2 summarises the manner in which it is believed the gorge tract between Coldstream and Berwick may have been formed by meltwaters. The high level terrace fragments at the mouth of the Till are difficult to interpret in view of the inherent difficulties associated with comparing terraces due to two different rivers but there is no known evidence from this area that, as Clapperton (1967) suggested, the Till was initiated on it's present course sub-glacially.

Analysing the sea levels associated with fluvial terraces is complex enough when full sequences are preserved. When fragmentary, as in the Tweed Valley and most other British localities, any results from this type of analysis become of dubious value. Taken as a group, however, and bearing in mind the evidence of the buried valley of the Tweed and the evolutionary model postulated for the development of the Coldstream to Berwick gorge tract, the high gradient terraces in the lowest section of the valley are probably related to a much lower relative sea level than exists at present. This statement assumes that the high gradient fragments did not once rapidly change their long profile form so as to achieve near-zero gradients before reaching the site of Berwick. It seems reasonable that the now-dry, deeply incised tributary valleys were initiated near and possibly inside the ice margin, becoming incised progressively while the ice margin shifted upvalley and a new set of proglacial outwash terraces was being formed. In this way the incised dry tributary valleys are believed to be progressively younger upvalley.

Heights gathered on flat surfaces of the Cornhill-Crookham sands and gravels in the Campfield area (858 379) showed these to exist between 120 and 125 feet above mean sea level. This compares with equivalent values of between 150 and 175 feet for kame terrace heights given by Clapperton (1967) in the eastern section of the complex. In combination with the rest of the quoted evidence of late-stage westward drainage (Chapter 5) this suggests a two-way split in meltwater paths at this period in the region of 865 370, one stream running eastwards, the other westwards towards Coldstream, near where it may have become proglacial, feeding some of the terraces in the Lennel area. Due to its linear nature in plan, the complex is well suited to a thorough and accurate analysis of the kame terrace heights: any firm conclusions on the relationship between this and the Tweed terrace sequence must await such a study and another of the relationship of the complex to meltwater channels and deposits around Coldstream and to the north.

Immediately to the west of these kames, kame terraces and kettle holes, however, in the lower section of the broad open valley of the Tweed which extends upstream to Kelso, the terrace sequence is certainly younger and most of it is considerably younger than these ice-contact landforms. Although much of the broad basin may be floored by stagnant ice deposits, drained only through the gorge at Coldstream, there is no clear evidence of ice-proximal outwash for some distance upvalley, except perhaps at 8320 3915 and possibly as F675. In view of the results gathered in the Rutherford and Abbotsford areas, it seems reasonable to interpret the broad flats common in the Fleurs Castle area and downvalley from it as ice-distant outwash related to ice margins represented by kame and kettle complexes directly upvalley from outwash at these two locations.

This interpretation, however, presents certain problems. The steep sided, sand-covered ridge commencing at 6786 3215 rises out of F578 and this fragment has been correlated with F585/584, the middle Fleurs terrace. Yet, if the ridge is a fluvioglacial feature rather than a modified ice-moulded ridge, the former continuation of F587/582 upvalley as suggested by F574 and 581 requires that this feature is a residual cut from terrasiform deposits, vast quantities of which deposits have been removed. In the light of present evidence, it is accepted that the ridge may be drumlin cored but considerably modified by meltwater erosion and deposition.

Contemporaneously with the older of these ice limits at Rutherford, the ice in the Teviot valley seems to have been very close to the junction with the Tweed, judging from the evidence of kames and kettle holes below the level of F582 and Clapperton's claim that these and kame terraces exist near present river level much of the way up this valley. Alternatively, it may be that the main ice in the Teviot disappeared at an earlier stage but that buried ice, later to form the kettle holes in the fluvioglacial deposits once melting out was complete, did not melt for some time after the formation of F582 and possibly some lower flats. Whatever the detailed explanation it seems safe to assume that some ice existed later in the northeast-trending Teviot valley than in the adjacent main Tweed valley. There is no known evidence to suggest that this is due to a readvance of Teviot ice rather than merely a combination of variations in the rate of melting in different valleys and distance to the ice sources.

There is every reason to suggest that the formation of the Makerstoun gorge is identical to that postulated for the similar feature between Coldstream and Berwick (figure 10.2). With the blocking of the possible buried channel to the northwest, meltwaters inside and those pouring out of the ice front probably cut down and back as the ice downwasted, leading to a feature diachronous both in depth and length. In common with the similar situations elsewhere, the halt stage in the general deglacierisation at Rutherford may represent little more than topographic effects, the ice being thicker in the pre-existing deeper valley and thus remaining in situ and possibly also active much longer there than over the wide, shallow valley cross section to the east. It is tempting to correlate the Tweed ice position at Rutherford with that of the Teviot ice at the Tweed/Teviot confluence but no evidence is available to support this save the lack of any manifestation of other stages below Rutherford. Upvalley from the outwash and the kames and kettle holes at Rutherford, dissected outwash exists at only slightly lower projected levels, apparently derived from around 628 307 and running obliquely downvalley between the ice moulded relief of the area. The 'upstream' extremity of this could not be mapped with any certainty. It may well be, therefore, that the Rutherford stage was relatively short and that the ice-marginal position from which issued the meltwaters which formed some of the Fleurs terraces is only obvious outside the field area. This emphasises the dangers of basing a deglacierisation pattern on areally-restricted fieldwork.

The problem of the Bemersyde gorge is rather different, in part due to its orientation, the downstream section being in general transverse to the grain of the surrounding countryside although extremely sinuous in parts. This may suggest that the river course was superimposed on to bedrock from relatively stagnant ice lying in the hollow between the Eildon Hills and those hills in the Bemersyde region. It may also be that this is in part an older course of the river, only slightly modified by ice and re-excavated by the Late-and Post-Glacial Tweed. There seems little possible doubt, in contrast with this, however, that the broad valley section upstream from Newstead is at least in part a result of glacial erosion, as is the final smoothing of the valley course in much of the Upper Tweed above Walkerburn.

The stagnation complex at Abbotsford from which may have come water contributing to the formation of the Bemersyde gorge as well as the formation of the Fleurs terraces seems to be explicable entirely on topographic grounds. At this point, the Tweed valley opens out and this, in combination with the presence of meltwaters from the Gala and Allan Water valleys flowing into the Tweed in the area around Tweedbank (516 350), is sufficient explanation for a stagnation complex at this point. It should be noted that although stretching across much of the Tweed Valley[1], the downvalley extent of the exposed ice-contact zone is only of the order of three-quarters of a mile and this may be diachronous.

1. The kames in the Allan Valley above Easter Langlee are probably due solely to a tongue of stagnant ice extending up this south trending valley and melting in much the same fashion as that in the Eddleston Valley (Sissons 1958).

Other things being equal, extrapolation of terrace profiles to obtain sea level heights becomes more difficult the further upvalley it is carried out. Nonetheless, in the crudest possible fashion, it seems reasonable to make the generalisation that the low gradient terraces up to 20 feet above the river in the Lower Tweed valley are probably related to the Fleurs terraces and thus to the Rutherford and Abbotsford halt stages, rather than to the high gradient terraces in the area below Coldstream (figure 9.35). If this is so, it suggests that during at least part of the stage at which these features were formed, sea level was relatively higher than present by several feet. That this is not due simply to aggradation in the river mouth area is shown by the raised beach underlying Spittal at about 14 feet O.D. and the lack of any known manifestation of fluvial aggradation anywhere in the estuary at about this altitude. Terraces farther up-Tweed than Abbotsford are definitely not relatable to sea level and thus the deduced sequence of relative sea level changes in this area can be summarised as an early low sea level (demonstrated by the buried channel and the high gradient terraces) when ice was still present in the Lower Tweed, rising to perhaps as much as 10 feet above the present by the time the Tweed ice margin was at Abbotsford and concluded by a fall to the present value in the succeeding period. It may well be that other periods of low sea level intervened between the high sea level stage and the present but this cannot be demonstrated on the available evidence. In parts of the Middle Tweed, however, the river level does not seem to have been below that of the present since the high sea level stage while at some points in the Upper Tweed it has not been higher than at present since the last ice in the area melted.

Part of the evidence for the latter statement is the low-level kettle hole at Rink Farm. While it is possible to interpret the kame, kettle hole and esker complexes below terraces at this point as the remains of proglacial outwash which included numerous detached blocks of ice, the length and extreme regularity of the terrace forms in comparison with the irregularity of the intervening hollows and gravelly mounds suggest that the whole system is ice-marginal and the flats are kame terraces. At least two stages are represented in the record of the long profiles of the terrace fragments of this area (figure 9.16). The higher and older feature may be contemporaneous with the Abbotsford complex while the lower flat probably post-dates it. Accepting this, it is possible to suggest that Ettrick ice may have been less decayed than Tweed ice at the time of formation of the Rink kame terraces and channelled drainage flowing supra, en and perhaps sub-glacially from both sides of the Tweed valley towards Rink. This suggestion is based on the number of ice-contact features on the left bank of the combined Ettrick and Tweed valleys in comparison with the few on the right bank. Supporting this, in so far as any support can be provided by the non-existence of features, is the non-appearance of similar marginal flats in the Ettrick except at much higher levels. At points where they might be expected only low level kames and kettle holes exist e.g. in the Tod Holes region (4_9 296). The non-preservation of more extensive features in the Tweed above Rink Farm is reasonable as a projection of the highest Ashiesteel terrace in a downvalley direction approximately intercepts the floodplain in the Rink area. Thus kames and kettle holes with intervening kame terraces further upvalley would have been destroyed at a later stage although it is also possible that this occurred in the Ettrick valley. As the terrace sequence in this valley was not examindd, it is impossible to decide if this is the case.

The Ashiesteel terraces, in association with the esker and kame and kettle complexes in the Holylee-Elibank area, provide the evidence of the next known halt stage in the disappearance of the ice cover after the Abbotsford stagnation complex. The Tod Holes near Selkirk may represent the equivalent stage in the Ettrick Valley. A complete sequence of feeding eskers with kames and kettle holes marking the position of the completely stagnant marginal zone of the ice is succeeded downvalley by proglacial outwash terrace fragments. No suitable topographic reason for the location of this ice limit can be advanced. It occurs 2 miles from the upstream end of a narrow and parallel-sided valley yet the fact that several terraces separated vertically by almost 100 feet commence in very nearly the same location suggests that this is an important and relatively long haltstage in the deglacierisation of the area. It may mark the limit of a readvance but there is no proof of this yet known to the author.

The valley section between Holylee and Peebles includes few terrace features save only the ubiquitous floodplain. Those that do occur probably represent fragments of the proglacial outwash originating in the Sheriffmuir area or may be relatively late-stage kame terraces. During or after the time when the ice finally melted from this area, numerous tributary valley fans were formed, perhaps banked-up against the edge of rapidly melting ice in the Tweed valley in some cases. While many of these are manifestly relict features, being truncated by the present river, some are believed still to be active in their upper sections. The large, essentially relict, fan on which Innerleithen stands is clearly related to Leithen Valley waters, being truncated by later Tweed terrace fragments, but the flat underlying Peebles, decreasing in height up the Eddleston valley, has either suffered considerable human alteration or is related to processes operative only in the Tweed valley.

The next known location in which the ice front stabilised for some time is at Sheriffmuir, Sissons'(1965) limit for the Perth Readvance in this area. All of the available evidence points to an ice front running across the Tweed valley in the region of Easter Happrew (192 398) and remaining in or near this position for some time, if the vertical difference in height of ice-proximal outwash terraces commencing at the same location and the scale of the features are any criteria of age. The Lyne valley, intersecting with the Tweed in this area, appears to be the ideal site for stagnation of ice if the postulated downwastage pattern of deglacierisation occurred. Narrow and transverse to the regional ice movement, joined only at its two ends by the main ice-flow routes, it is entirely reasonable to assume that evidence of decayed ice in the form of kame and kettle complexes should be prolific. Yet only one very low terrace is present, the higher flats stopping abruptly at Five Mile Bridge as previously described (Chapter 7).

The arguments for the Lyne terraces originating not as subaerial outwash but by deposition from the Tweed meltwaters in a lake can be summarised as follows:

a) they are flat-topped (Price 1961)
b) they come to an abrupt end (deltaic deposition?)
c) no dead ice features exist up the Lyne valley from Five Mile Bridge
d) foreset and topset deltaic bedding was observed under a planar-surfaced sheet of sand and gravel at Ladyurds, 3.5 miles up valley, suggesting the former existence of a lake.

It is now known from the results tabulated in this thesis that a) is incorrect. None of the terraces in the Sheriffmuir area can be said to be horizontal. Fragment 222, for example, has a marked gradient, falling in height both parallel to and away from the river Lyne. Significantly, perhaps, the abrupt end of the Lyne terraces noted in b) coincides with a quarry face showing massive greywacke rocks to underlie the flats i.e. they are rock-defended. The surface of the sheet of sand and gravel noted in d) was formerly at an altitude of some 850 feet, about 150 feet above the F222 and 224. It has already been noted that Midland Valley erratics have been found in stone counts in terrasiform and non-terrasiform deposits in the Lyne valley (appendix 5) while the surface expression of all Lyne terrace fragments slopes down that valley, sometimes very steeply. Fragment 212, a kettled outwash terrace fragment has no significant decrease in altitude up the Lyne valley and thus at this stage of deglacierisation, the Tweed meltwaters probably did not contribute directly to the deposits near Hallyne. Similar conclusions can be derived from the form of the large F216, applying to a later stage.

Accepting all this, the following tentative sequence of events in the area is suggested on the basis of the continuation of downwasting as the principal means of ice disappearance:

1) Tweed ice existed at the Easter Happrew limit, having split from that in the Lyne valley which had become stagnant, the surface layers becoming increasingly decayed. From this decayed ice, meltwaters built F222, 224 and 230 while F212 and subsequently F216 and 214 were formed by aggradation of outwash in front of the Tweed ice, the margin of which remained in a near constant position. Simultaneously at several locations along the valley, streams were running on to and into the decaying Lyne ice and, at an early stage at

least, an ice-marginal lake was impounded by the as yet undecayed layers underneath (at Ladyurd).

2) An unknown time interval later, the considerable amount of meltwaters released from the melting of ice in the Dolphinton area (Price 1961, Sissons 1967a) began to escape down the Lyne during the final stages of break-up of the stagnant ice. Probably owing to the bedrock outcrops at Five Mile Bridge, F222 and 224 were preserved while the meltwaters removed or buried under the single low terrace all vestige of other terrace forms or dead ice features above this point. Sand and gravel carried by this greatly enlarged Lyne merged with meltwaters from the by-then largely ice-free Meldon and Edston valleys. In addition, meltwaters from the receding Tweed ice front combined with Lyne-channelled waters to form such terraces as are now represented by F240, 268 and 208. The last noted is clearly the floor of a substantial proglacial meltwater channel cut through F216, 206 and 214.

3) Shortly afterwards, the continued melting of the Tweed ice must have outpaced the dissection of F216 and downcutting continued solely in another section of the braided channel pattern of which F208 is the floor of one part. Thus meltwaters assumed approximately the present Tweed course and a series of small terrace fragments on the east bank of that river record the progressive incision that ensued as the ice continued to melt. Fragments 238, 252 and 254 are later products of the mass of sand and gravel being shifted downvalley by these and Lyne-channelled meltwaters. It is likely that the infilling of some of the larger basin sections of the Tweed, such as that east of Innerleithen, up to or perhaps even slightly above the present level was accomplished by these deposits. It is suspected that in most of these basins only local resorting of the materials and

re-arrangement of the surface has been accomplished by streams in recent times.

4) Following the upvalley continued 'retreat' of the Tweed ice and the gradual diminution of Lyne-channelled meltwaters, small tributary fans were gradually built up, particularly on the south side of the Lyne, as at 174 416.

It is recognised that this sequence does not explain all the features mapped in an entirely plausible fashion. Nonetheless, no equally simple viable alternative is possible in the light of available evidence. Although the explanation offered does not implicitly involve a readvance it may be that the deposits were laid down at the end of, say, the Perth stage, as Sissons (1965 p.479) stated that this is associated with extensive outwash in eastern Scotland. There is no evidence known to the author, however, that the ice limit at Sheriffmuir represents the maximum of a readvance although if it were not possible to show that both the terraces and some of the terrasiform deposits are probably related to water flowing down the Lyne valley, the Tweed valley-ice readvance would be a reasonable solution to the lack of terraces above Five Mile Bridge. It would not explain however, the sudden cessation of these flats except by again invoking removal of the non-rock defended parts by Lyne-channelled meltwaters. Furthermore, at whatever stage ice last melted in the Lyne valley, one might reasonably anticipate that ice-contact deposits should have been formed and persisted as in the Cornhill to Crookham depression, by virtue of the relationship between the trend of the valley and of the predominant ice movement in the area. Their absence in such a suitable location for stagnant ice suggests that removal by meltwaters must have taken place at one stage or another. While a readvance may be demonstrated by the thick till[1] overlying laminated lacustrine clays in the Neidpath area, it could either be that this is a very much older event or that it represents the early stages of a readvance which was terminated by the Sheriffmuir outwash.

Apart from lower flats in the Stobo area, some of which contain possible kettle holes and may thus have been formed within a mile or two of glacier ice, the only demonstrably ice-contact terrace fragment as far upvalley from Stobo as Drumelzier is F209, probably a kame terrace fragment in view of its kettled surface and the lower kame and kettle complex. At Drumelzier itself, the numerous kames protruding through the Tweed floodplain and rising some 60-90 feet up the sides of the valley indicate that the Tweed probably remained ice-filled until a relatively late stage, in comparison with the Biggar and Holm Water valleys. The existence of several terrace fragments in the Holm Water valley, up to 35 feet above the present floodplain and kettled in some cases suggests that outwash was deposited by meltwaters flowing down this valley while a lobe of ice, the margins of it stagnant, protruded out of the Tweed into the downvalley extension of the featureless Biggar Gap. At certain stages, at least some of these meltwaters were derived from the marginal drainage of the Tweed ice: the correlation of F142 and 150 (Plane P12, figure 9.6) strongly suggests a water flow from the Tweed ice through the col south of Rachan Hill and into the minor valley, largely ice-free at this stage.

Several possible explanations exist for the inter-valley differences in the deglacierisation pattern. It is important, however, to recognise the quality of the evidence as similar features to those in the Tweed may once have existed in the Biggar Gap, having subsequently become buried. An obvious explanation is that a readvance occurred of Tweed ice when that in the Holm Water and the Biggar Water

1. If this till is in situ.

valleys existed only outside the limits of the present field area. It seems likely that the Holm Water terrace fragments, approximately parallel to the present stream, are the remains of ice-distal outwash from ice melting at this time. Alternatively, the explanation, at least in part, may be a combination of the variation in valley topography and insolation effects. At Drumelzier the Tweed valley form changes to a much narrower form than that immediately downvalley. Thus the sudden diminution in surface area would naturally cause changes in the rate of melting of the ice in this area and, in association with the variations in insolation intensity, would possibly explain all except the non-occurrence of glacier ice in the Tweed-proximal sections of the Holm Water valley.

It has long been accepted that a readvance, J. Geikie's 'Valley glacier stage' followed the disappearance of the main ice sheet in the higher parts of the Southern Uplands. This has been based in the past upon such evidence as the non-existence of till within the postulated readvance limits, being replaced by the morainic mounds which Sissons (1967 a ,p.141) has interpreted as being of Zone III age and thus equivalent to the Loch Lomond Readvance of Highland Scotland.

Laminar surfaced sheets of sand and gravel were located in the mouths of 7 tributary valleys in the mapped area, those of the Kingledores, Menzion, Hawkshaw, Fingland and Glencraigie Burns and the Talla and Fruid Waters. Their gradients in virtually all cases exceed 50 feet per mile and, despite the present stream gradients often being of this order, it is suspected that many of these sheets of sand and gravel are ice-proximal outwash. There is no proof, however, in any of the tributary valleys that the readvance moraines are directly linked with the outwash: in no caseare they juxtaposed. It is quite permissable, therefore, to regard the latter, in the light of present knowledge, as part of the evidence for a continued ice recession into the high altitudes of the tributary valleys. On this interpretation the older features would be those in the lowest tributary valleys e.g. the Kingledores outwash would be older than that in the Menzion-Fruid-Talla complex. Alternatively, the ice may have melted almost entirely and then readvanced, such that the outwash sheets are pene-contemporaneous, probably formed as the ice finally melted. On the evidence available at present, it is impossible to deny the possibility that a combination of these events actually occurred, the outwash being of different ages and formed during the recession, not necessarily at the maximal extent, of the readvance of valley glaciers.

However and whenever the outwash originated, some description of the landscape of the time is still possible. Principally by downwasting, ice in the area became confined to the major valleys. Thinning and 'retreating' as the effect of a negative mass budget, the glacier front shifted upvalley, perhaps being stagnant in the extreme frontal zone as indicated by the buried kamiform deposits at Tweedsmuir. Along the glacier margin it seems that marginal and sub-marginal meltwater channels were cut. Outwash aprons from ice in tributary valleys spilled across the entire width of the Tweed valley at these altitudes. Drainage from up-Tweed sources occasionally seems to have been concentrated on the opposite side of the valley in the areas around the mouth of the Fruid, perhaps cutting some of the lower 'marginal' meltwater channels and also the course of the present Tweed (in this area) subaerially by superimposition from sand and gravel on to bedrock.

A similar situation seems to have existed in the Kingledores area where F187 is probably an extension of F112 emanating from the Kingledores Burn valley. The considerable altitude of some of the flats in this area, in particular F126, suggests that these may be kame terraces rather than the remains of proglacial outwash. As meltwaters depositing all the outwash reached the main valley, they swung down-Tweed and continued their flow, probably forming the now-elongate terraces and terrace fragments such as F90 and 96. Projection of the gradients of these fragments believed to be associated with the presence of ice in the tributary valleys suggests that they pass below the level of the floodplain in the Drumelzier area, thus avoiding any problem of the formation of the kames there subsequent to the presumably much later formation of the terraces further upvalley.

Age relationships between terrace fragments in the Upper Tweed and what are believed to be solifluction deposits are not clear. While the low terraces such as F9 clearly post-date such deposits as those underlying the Badentree fan (section 27, appendix 6), the higher terrace fragments are not found in close proximity to them. Both the lip of the fan and the surface of F1 are at comparable altitudes, separated by 150 yards but the non-existence of any gravel under the fan suggests that these deposits pre-date the outwash.

In several parts of the Tweed Valley proof exists and inference is possible elsewhere that, excluding the areas adjacent to tributary junctions, the river has been little higher but may have been lower than at the present day since the last ice left the region, probably at least 10,300 years ago (Sissons 1967a p.141 and 146). The artifacts found at Rink Farm (Chapter 6) suggest that in this area the floodplain has long been about its present location. Thus it seems reasonable to suggest that except in the estuarine area, affected even by small changes of relative sea level, the river gradually attained its present level during and shortly after the dissolution of the glaciers. It is likely that since this period the vertical variations in river profile have been small, terrace formation being much restricted in comparison with that in Late-Glacial times.

CHAPTER 11.

TREND SURFACES AND TERRACE FRAGMENT CORRELATION

A. The History of Trend Surfaces and their Comparison.

Computed trend surfaces have long been discussed as logical, two dimensional extensions of the single dimensional regression or 'best-fit' line. Their use as descriptive features, particularly where high orders of the variables are involved, only became possible with the availability of high speed electronic computers. The progression from the earliest fitting of multi-dimensional trends to areally distributed data, such as that by Krumbein (1956) to the commonplace usage by Chorley and Haggett (1965), Read and Dean (1967) and many others at the present day has thus spanned little more than a decade.

Most of the current work involving trend surfaces uses these as quantified summaries or simplifications of the overall trend, separating this from the noise (or local effects) at various scales of viewing. As Lee and Middleton (1967 p.19) remarked, this rarely provides results not obvious from simple visual inspection. A few geologists and geographers, however, have attempted to correlate sets of data by quantitatively comparing trend surfaces fitted to all the sets. The earliest attempt to thus compare areally distributed data in a quantitative fashion in the environmental sciences appears to have been that by Robinson and Bryson (1957). They attempted to find a relationship between farm population density and rainfall in Nebraska.

More sophisticated studies have recently been made by Miller (1964), Merriam and Sneath (1966), Rayner (1967) and Rao and Srivastava (1967). Merriam and Sneath (1966), in analysing the similarities between trend surfaces fitted to various stratigraphic horizons in Palaeozoic rocks in Kansas, employed two methods to compare the cubic surface coefficients. The first of these hinged on the concept of taxonomic distance, d, between j and k, represented by

$$d = \left[\frac{1}{n} \sum (X_{ij} - X_{ik})^2 \right]^{1/2}$$

where X_{ij} is the value of the i th character of j, X_{ik} is the value of the i th character of k and n is the number of characters. Weighting of each coefficient was achieved by standardising each term so that it had a mean of 0 and a variance of 1. The other method employed was of deriving the correlation coefficient r for combined surfaces brought to the same mean level. From these values, dendograms were drawn to illustrate the relative similarities of the surfaces fitted to the different stratigraphic horizons.

Mandelbaum (1966) criticised these procedures as employing several arbitrary manipulations, in particular the method of standardisation and suggested alternative weighting techniques. Rao and Srivastava (1967) agreed with Mandelbaum in stating that it was impossible to compare two trend surfaces with the Merriam and Sneath distance function as they will have no standard deviation. These authors also expressed the feeling that Mandelbaum's method of weighting would make the calculation procedure biased. In comparing two subset trend surfaces, essentially to study internal consistency of the results, their investigations of the validity of distance functions yielded results which did not correspond to those derived from different methods, although, in contrast to Merriam and Sneath, they included the constant term of the trend surface equation in their calculations. It is clear that much more investigation in depth of the techniques of surface correlation is required, particularly as more methods are coming into use. Rayner (1967), for example, published a theoretical study of techniques of correlation between surfaces by spectral methods.

B. Statistical and Programming Techniques used in this Study.

Due to the lack of both general agreement on the best means of correlating surfaces and time to carry out experiments on this point, only one simple technique was employed in this study. This is based on a comparison of the variance between two surfaces with the 'internal variance' of both, treated separately, and was tested by an F test on the null hypothesis that no significant difference existed between these estimates of variance. Thus the initial condition for declaring two terrace fragments as paired, that the mean difference in height between them is no greater than the mean variation in height of either surface (Chapter 2) was employed in this analysis of variance. Such a stringent condition for pairing could easily be relaxed by comparing the estimated variance between the surfaces with some multiple of that for each surface.

The general procedure employed in this largely experimental study, of necessity limited to only a few large fragments in the Fleurs Castle area, was as follows. First, second and third order trend surfaces were computed for each fragment or composites of fragments in the area using a modified version of the O'Leary, Lippert and Spitz (1966) FORTRAN IV program, run on a Univac 1108 and an I.B.M. 360/65. For reasons that will become obvious, only linear and quadratic surfaces were employed in the final analysis. Figure 11.1 illustrates typical contoured trend maps from this program, derived from the maps produced by a lineprinter.

The most commonly used measure of reliability of the fitted surfaces is the sum of squares test, based on the percentage of the total sum of squares of a particular variate (terrace altitude in this case) accounted for by a surface of a given degree. Howarth (1967) showed that where this value, the coefficient of determination, does not exceed 0.6, 12.0 and 16.2 percent for linear, quadratic and cubic surfaces respectively, the mapped variable probably does not differ significantly from being random in nature. As all the values obtained for the coefficient of determination were far in excess of these thresholds, it was accepted that further analysis was justified as the trend surfaces adequately explained the data.

The general procedure for the next stage was as follows: where the fit of each surface to the single terrace fragment, as expressed by the r^2 value[1], was good, the equations of this and the other supposed correlative surface were inserted in F-CAL, an Atlas Autocode program developed for the purpose of analysing the estimated variances. This program, listed in full in appendix 8, first reads in the coordinates and height values on terrace fragment A, as derived from fieldwork. In the case where the effects of different data distributions are being studied and only one terrace fragment is concerned, the computer then calculates the deviations of the actual values from the theoretical values of height of the fragment at each of the sampling points. In addition, the mean and standard deviation of these values are calculated and a histogram plotted by

1: r^2 = coefficient of determination, where r = coefficient of correlation.

grouping the values into twelve categories from plus three to minus three standard deviations, to test that the distributions of the first and second order residuals are both approximately normal. This operation is repeated for the second pair of first and second order surfaces fitted to fragment A from different samples, except that the same coordinates are used as previously. The same calculations are also performed on the differences between the two similar order surfaces at these coordinates. Although most distributions of residuals or differences were approximately normally distributed, this may not be of great importance as McIntyre (1967 p.46) has recently stated that "although the least-squares criterion does not require any assumption of normality, tests of significance usually do. Fortunately it seems that most tests are robust i.e. departure from normality is not critical."

In cases where the data sets were not wholly overlapping in this manner, such as in the comparison of discrete terrace fragments, a modification of this method was employed whereby surfaces fitted to fragment A were compared with composite surfaces fitted to both A and fragment C, titled B. In addition, trend surfaces fitted to fragment C were projected over the area of fragment A and similar calculations carried out. If the residual and difference values are considered to be tabulated in columns, each column consisting of Nc values, where Nc is the number of geographic coordinates at which points heights were gathered on fragment A, the variation between column means is given by Croxton (1959 p.297) as

$$\sum_{1}^{Kc} \left[\frac{\left[\sum_{1}^{Nc} X \right]^2}{Nc} \right] - \frac{(\Sigma X)^2}{N}$$

while that within columns is expressed by :

$$\sum X^2 - \sum_{1}^{Kc} \left[\frac{\left[\sum_{1}^{Nc} X\right]^2}{Nc} \right]$$

where $\sum_{1}^{Nc}$ refers to a summation of the values of the Nc items in a column and $\sum_{1}^{Kc}$ refers to a summation over all the Kc columns. As in this case two sets of residuals and a set of differences are involved, Kc = 3 and thus N = 3 x Nc for each order of surfaces considered. The symbol X refers to a residual or difference value.

The estimated variance is obtained by dividing the variation between column means and that within columns by the respective degrees of freedom. In all calculations involved, these are 2 and 3(Nc - 1). Thus the F value, as Croxton (1959 p.299) stated, is derived from

$$F = \frac{\text{Estimated variance between column means}}{\text{Estimated variance within columns}}$$

and this is then compared with an F table to see if it is significantly larger than would be expected at given probability levels. Finally the whole process was repeated by switching the A and C data sets and thus employing different coordinates and different values for Nc.

While not possible in the case where various surfaces fitted to a single fragment are being compared, some objection may be made to this method where surfaces are fitted to two fragments simultaneously as, by the nature of trend surfaces, values are being compared with others which are a partial function of themselves. Put another way, the comparison of the theoretical values $X^T_{A_j}$ ...... $X^T_{A_j + n}$ derived from fitting a certain order surface 1 from the actual values $X^A_{A_j}$ .... $X^A_{A_j + n}$ with the theoretical values $X^T_{B_j}$ ....$X^T_{B_j + n}$ derived from fitting the same order surface 2 from actual values $X^A_{A_j}$......$X^A_{A_j + n}$

and $X^{A}_{Cj}\ldots\ldots X^{A}_{Cj+n}$ on fragments A and C respectively would seem to employ the only partly independent values $X^{T}_{Bj}\ldots\ldots X^{T}_{Bj+n}$ in an important role. Yet an entirely similar method is widely accepted in the field of statistics for comparison of the coefficients of like terms in polynomial equations (Johnston 1963 p.136). The most recent published quantitative comparison of trend surfaces (Rao and Srivastava 1967) does not discuss the error effects of non-independent data sets.

C. Problems Associated with the Use of Trend Surfaces in Terrace Studies.

Quite apart from statistical considerations, however, a number of other methodological points are important in this particular study. The first of these is that low order surfaces must be employed as high order equivalents could still provide a very good fit to two clearly unrelated surfaces. For this reason, only linear and quadratic surfaces were employed. Yet fitting a linear surface to fragments which are inclined across valley as well as in a downvalley direction could result in a very poor correlation between two such surfaces fitted to two fragments on opposite sides of the river, especially where substantially different numbers of heights were available on the different flats. The advisability of ensuring that comparable numbers of spot heights exist on two fragments to be compared involves gross variations in the density of heighting required and thus presumably also of the accuracy of characterisation of the flats in question. Surfaces or projected surfaces fitted to each of the two fragments would cross, in shed roof-like cross profile near the centre of the valley, the location of the line of intersection being a function of the cross valley component of slope and relative height of each surface. Thus to give meaningful cross valley comparisons of two fragments not immediately opposite each other it may be essential to invent mirror-image equivalents of each fragment, the mirror position being represented by a vertical plane down the centre of the valley at that height. If this were carried out, linear planes would be horizontal in cross valley profile, bisecting the real and imaginary terrace fragments.

A second methodological limitation is that initial simultaneous correlation of all or many of the terrace fragments along a river is not possible. The use of low order trend surfaces necessitates the assumption that downvalley gradients over short distances are approximately constant, which is in any case a fundamental of terrace fragment correlation by altimetric means, except where it can be shown to be in error by study of the underlying terrasiform deposits. Only step by step correlation, correlating A_{1-p} with B_{1-q} and B_{1-q} with C_{1-r} and so on is possible[1].

It is well known that surfaces fitted using orthogonal polynomials should not be projected far outside the control area. If this is done they may become extremely unstable and the derived values can be extremely unreliable (James 1966). Naturally this complicated the analysis, necessitating the adoption of the statistical methods described above. In future, it is intended to check the results of this study by fitting surfaces based on Double Fourier series. While convenient, relatively easy to implement and reliable for low order surfaces, the O'Leary, Lippert and Spitz (1966) program frequently gave poor results when trial runs were extended to higher degree

1: p, q and r are the number of terrace fragments in vertical sequences at succesive points A, B and C respectively within a river valley.

surfaces. Divergence of the r(correlation coefficient) values occurred frequently at the third or fourth order level due to the inverting of an ill-conditioned matrix (Krumbein and Graybill 1965) obtained in this program by relatively unsophisticated statistical techniques.

Figure 11.2 illustrates the problem resulting from fitting a first order trend surface to height data and then projecting this in any manner downstream. Although a uniform gradient exists along a line AB, a line along the centre of the valley[1] represented by ABCD, when graphed against projected height of the computed surface into a projection plane on this base (along which the fragments are roughly orientated), shows a non-uniform gradient (figure 11.2b). Figure 11.3 shows an extension of the problem: even where a higher degree surface is fitted which will follow the first part of the curve of a valley meander, the usual asymmetry in plan view of many of these arcuate features results in a marked discordance in desired and actual positions of the surface a short distance downvalley. In the situation where surfaces fitted to one fragment and to this fragment in combination with another which is a little way around the meander from the first fragment are compared, a simple surface will probably suffice in the first case while a much higher order equivalent may be required in the second to give a comparable goodness of fit. Where the higher terms in the equation of such a surface contribute significantly to the surface form, it is impossible to compare the different order surfaces. Thus on this basis, terrace fragment correlation is best restricted to near-straight valley sections.

1: valley in this case need only mean that immediately enclosing the terrace fragment, perhaps made up of the scarps fronting higher terraces.

From these problems, certain conclusions can be drawn:

a). that low degree surfaces must be used for terrace fragment correlation.

b). that some means of testing the safety of the technique already described for deriving common coordinates for surfaces fitted to two fragments would be useful.

c). that correlation of fragments all on one side of a valley is often easier and more reliable than cross valley correlation.

d). that some means of avoiding the problems of terrace remnant correlation within a meandering valley would be useful.

e). that the effect of data distribution on all results, previously discussed in Chapter 3, may be substantial and must be analysed.

Most of the conclusions will be discussed in greater length in section D of this chapter, dealing with the results obtained. However, a description of the technique devised to satisfy d) must be given as this was used intensively in the derivation of these results. The supposed inherent low degree of correlation likely between surfaces fitted to fragments within a meandering valley was obviated by steering the surfaces around the meanders. This was accomplished by referring the coordinates of all heighted points to distance down a line around the rear of a terrace fragment (where the valley sides are parallel or sub-parallel) from an arbitrary origin and to perpendicular distance from the same line, rather than, as previously, to the National Grid. Thus, in appendix 1(b), both P(distance downline from O), Q(perpendicular distance from line) and National Grid coordinates of all the points on the Fleurs terraces are given.

Effectively, this technique straightens out the valley, resulting in compression and stretching in different sections of the fragment. Because of this, original point distribution patterns are distorted where the valley walls are sinuous and this is particularly noticeable where the original layout was a rectangular grid. The sinuousity of the line also leads to an ambiguity of plotting as outlined in Chapter 8; in some areas a given point may have more than one possible set of coordinates. Experiments showed that because the sinuousity index of the smoothed valley sides at this height, ignoring small gullies, was usually small in the section of the Tweed Valley where the techniques were tested, such ambiguity appeared to be small in degree. The convention of plotting each point at the first possible location on the sinuous plane was employed, when plotting sequentially in a downvalley direction. Where the valley sides are not parallel or sub-parallel, it would probably be necessary to take a medial line down the valley as the X axis of the new 'orthogonal' coordinate system.

D. Results of the Present Investigation.

Trend surfaces were fitted to data gathered on fragments F 584, 585 and 586/588 and also to fractions of the total data available for F 585 and combinations of all three terrace fragments treated in pairs. These fragments were selected both for their areal extent which made surveying relatively simple but also because, on the basis of the normal methods of correlation (Chapter 9) it seemed fairly certain that F 584 and 585 were contemporaneous while 586/588, perhaps a composite feature, was rather lower and presumably younger. Thus , although non-altimetric data is strictly necessary to confirm this, a basis for investigation of the merits of the trend surface comparison technique exists.

The equation coefficients of all the trend surfaces, their correlation coefficients, standard deviations and the number of individuals involved in the calculations are set out in sections A and B of appendix 3. Section C of that appendix contains information pertaining to the comparison of the listed surfaces. This includes the F values and the degrees of freedom associated with the calculation (V_1 and V_2). The M value is the smallest integer multiple of estimated variance within columns necessary to reduce the actual value of F below the significance level at the .001 probability level (where this multiple is greater than 1), to conform with the null hypothesis that there is no significant difference between the estimated variance between column means and that within columns. These M values were calculated on the assumption that the 'significant' F value at the .001 probability level for $V_1 = 2$ and $V_2 = 130$ to 600 is approximately 7.2.

Accepting the correlation between F 584 and 585 as demonstrated, a number of important conclusions can be derived from the data. The first of these is that there seems to be little difference in represent-ation of a surface with the use of different data distributions, certainly where a comparable number of heights is involved. Thus the 12 comparisons of surfaces generated from randomly distributed, clustered and gridded heights on a section of F 585 produce extremely low F values, in most cases below the significance level where M = 1. The few higher values of F, requiring an M value of up to 5 to ensure that there is no significant difference between the estimated variance between column means and that within columns, seem to be associated with the quadratic surface fitted to randomly distributed heights. Conversely, the quadratic surfaces fitted to heights around the rim of F 585 and to those on a rectangular grid over the whole terrace seem to fit together better than do the linear surfaces. It is suspected that the relatively good fit to all the surfaces associated with the latter pair of data sets is largely due to the one cross traverse on F 585 present in the A3 data set being a very close approximation to the terrace cross section as a whole. In other words, little variation must occur in the terrace cross profile up and downstream from this point although the better 'fit-together' of the second order surfaces as compared with the first may suggest that some does occur. With no cross traverses, using only data collected around the terrace rim, the derived trend surfaces would almost certainly have 'blown-up', becoming unstable at a low order surface. Other workers have found data distribution to affect markedly the results they obtained and this seems to be particularly a problem where opportunities for data gathering are restricted to sites such as infrequent rock out crops or where the overall distribution is markedly elongate rather than rectangular. (J. Doveton pers. comm.)

In view of the good results achieved in comparing the variously distributed data sets on a section of F 585, those obtained by comparing the whole of this terrace fragment (A5) with its up (A6) and downstream (A7) halves are a little disappointing. Although low in comparison with the results from some obviously miscorrelated examples (e.g. A2 and A12), the M value is as high as 22 in the case of the comparison of A5 and A6. Even higher values appear necessary where A7 and A6 are compared, rather than when one half is compared with the whole fragment. This emphasises the dangers of extrapolation of trend surfaces even a small distance outside the control area.

It is manifest from the results that,despite these dangers inherent in extrapolation of trend surfaces, the practice of comparing surfaces fitted to single fragments with those fitted to this fragment and another, or the reverse comparison, is unwise and should be discontinued. The resultant F value seems to be largely unrelated to whether the combined fragments are correlative or not, even using low order trend surfaces (e.g A1 and B1 in comparison with A1 and B3). Indeed, the only manifestation of such a miscorrelation is usually the occurrence of a much larger standard deviation for the height values of the combined fragments in comparison with those for each fragment individually. This does not occur when the two combined surfaces are correlative (e.g. B1 in comparison with B3). Thus the standard deviation of the Z (height) values may be capable of use as an indicator of miscorrelation.

In contrast to the frequently good results achieved by comparison of surfaces fitted to single correlative fragments and also to those fitted to miscorrelated pairs of fragments, comparison of the surfaces fitted to individual fragments believed not to be correlative was extremely successful in that very high F (and thus M) values were obtained, in two cases exceeding 5000. As an illustration, the F values for the comparison of first and second order trend surfaces fitted to data sets A2 and A5 are approximately 190 and 120, while the corresponding values for A2 and A12 are 931 and 2010. However, the variation in F amd M values even for believed-correlative surfaces is such that, at this present stage of analysis, it seems more reasonable to accept as correlative the two surfaces of three with the best fit and not to set up any rigid hierachical scheme for the limitations to pairing (except if in all cases the F value is consider -able, say in excess of 1000, and then to pronounce that none of the surfaces are believed to be paired). Much more work is needed to analyse the effects of variations in numbers of heights on fragments and other variables before such a hierachical scheme is justified; at present, therefore, it is possible to say that A and B are more nearly paired than A and C but only rarely can it be stated that all of them are definitely not paired within reasonable limits.

On an initial analysis, the comparison of trend surfaces fitted to R coordinate-located data seems to have no advantage over that involving the more usual National Grid-located data. Of the 10 comparisons of terrace fragments made in which both NG and R co-ordinates were used (leading to 20 F and 20 M values),both R and NG-style data sets provided the best 'fit-together' of the two surfaces concerned in 8 cases while in the remaining 4 cases the difference between the values from the different data sets were not significantly different. However, in certain cases where expected, such as the comparison of F 584 and F 585 (A1 and A4(NG), A2 and A5 (R) and their reversals), the R coordinate-located data usually gave a better fitting -together of the two surfaces. In such circumstances lies the theoretical and possibly great practical advantages of the re-ordering of the coordinate system: wherever marked sinuosities exist in the valley course, this system probably leads to better F values for correlative surfaces but not for those which are non-correlative (compare the A1 and A11 (NG) results and their reversals with those derived from A2 and A12 (R) and their reversals). It is clear that much more work is necessary on this in an environment of numerous, sinuous terrace fragments before this hypothesis can be substantiated or firmly rejected. In such an environment, a more detailed analysis of the effects of plotting ambiguities would have to be made.

An analysis of the results derived for first and second order trend surfaces produced the following. Considering all the comparisons between surfaces, the first degree surfaces fitted together substantially better than the second degree ones in 13 (33%) of the cases, the second degree 'fit' was much better on 15 occasions (38%), while on 11 occasions (29%) no significant difference existed. When this analysis was restricted to those surfaces showing a good or moderate fit, the corresponding values are 11 (35%), 10 (32.5%) and 10 (32.5%). Thus there is no reason to believe that either of these order surfaces produces a better 'fit-together' than the other. In all cases, the second order surface fitted the original data better than the first order variety, as shown by the explained variation, but it seems that in the comparison of two second order surfaces, local factors in each data set may have overriden the regional factors to the extent that no better 'fit-together' of correlative surfaces was obtained. It is therefore likely that (as suggested in section C with reference to surfaces fitted to combined fragments) no advantage is to be gained from fitting higher order trend surfaces to the data sets.

In conclusion, several problems are seen to be associated with the use of the technique and further work is necessary for their rigorous examination. The success, however, of the method in differentiating manifestly miscorrelated fragments is such that it encourages further work on these lines, if possible where correlation has previously been carried out on a non-altimetric basis. This analysis has, it is believed, been successful in at least demonstrating both the inadvisability of employing trend surfaces fitted to combinations of terrace fragments and, in the case examined, the small differences attributable to different data distributions, but the relative merits of different coordinate systems have not yet been resolved. It is also desirable that future work should include investigations of other techniques of correlation of the surfaces, perhaps either by distance functions or trigonometric methods.

CHAPTER 12.

A SUMMARY OF THE PRINCIPAL CONCLUSIONS.

This study was carried out against a background of previous terrace studies in glacierised areas and was based on altitude and gradient of the flats and all the known geomorphological knowledge concerning the Tweed Valley. Its aim was to test the kind of conclusions made about terraces in the past on altimetric evidence in similar environments, if necessary suggesting modifications or improvements to the manner of working and interpretation of the results, and also to extend the regional knowledge to include the pattern of deglacierisation so far as this is possible from a study of terraces and other adjacent deglaciation phenomena. Maintaining the dichotomous division into systematic and regional aspects employed elsewhere in the thesis, this summary will be divided into two sections.

A. The Methodology of Obtaining Conclusions from Terrace Heights.

The location of heights on any terrace fragment and its extension, the resultant areal distribution pattern, may very well have some bearing on the detailed results obtained, particularly where simple height layouts are employed. The simplest of all schemes, that consist -ing of single lines of heights down terrace remnants involves the assumption that these are genetically significant spots or at least adequately represent the fragment as a whole. The difficulties of ensuring that this is always so suggest that much more satisfactory results would be obtained from heighting on a rectangular or triangular grid pattern or on a randomly distributed basis. The first of these possibilities gave good results and offers relative ease of layout in the field but suffers from the possibility of certain harmonic elements of the surface relief escaping through the fixed grid-size filter.

It is quite futile to discuss or to be concerned with the niceties of the location of heights on terrace fragments if the means in which they are measured is basically inaccurate or worse, if it is occasionally and uncheckably inaccurate. Enough evidence has been gathered to show that only accurate instrumental levelling or tacheometry can provide raw data of a consistently high-enough accuracy in the Tweed Valley-like conditions. The aneroid barometer was found to be quite unsuitable for terrace studies in such an area. Other suitable techniques, however, may be available in the near future.

Even if accurate-enough results are available, as those in appendix 1(a) certainly are, conclusions drawn from the currently accepted means of representation of these on some variant of height/distance graph may be unsatisfactory due to the inherent distortion effects. It is possible in certain circumstances to draw conclusions, particularly with regard to correlation between supposed contemporaneous fragments or to the relationship between apparent knickpoints or nickpoints in the present river surface and low terraces, which are due solely to the data analysis system rather than being a primary function of reality. Both curvilinear and linear planes of projection distort the represented form of the terrace fragments in partly predictable manners and this must be allowed for in any analysis, particularly in the regions around the junctions of linear projection planes.

Little discussion has ever been published on the limits at which terraces can be considered to be correlative when reproduced on these projection planes. In this study, downvalley correlation was carried out by visual inspection but was by any means often impossible due to the multiplicity of terrace fragments related to different stages of ice retreat. It is feasible and technically easy to correlate projected terrace fragment heights by a number of statistical methods but in view of the possible representation error and inherent projection plane distortions, this apparent objectivity is, in Tweed Valley-like conditions, quite pointless. Nonetheless, correlation and regression techniques are useful for comparing the internal consistency of the values derived for different samples of a terrace fragment's gradient. These occasionally showed significant variations where based on less than 7 accurately heighted and located points. Where the terrace is patently a present-day floodplain this threshold value can be reduced to 5 or 6.

Within broad limits it was found possible, sometimes unambiguously, to assign terrace fragments and terraces an origin on the basis of their downvalley gradient where it was based on a number of height values in excess of this threshold. It is essential, however, that all other available evidence, morphological, stratigraphical or otherwise, be integrated into the final analysis, as the category limits of the classification scheme devised for and used in this study are based on landforms currently active in other parts of the world which may not be in all respects directly comparable to Tweed Valley conditions.

Cross valley correlation of terrace fragments is a much employed but rarely analysed technique: the criterion suggested for two terraces or terrace fragments to be paired is that the mean difference in height between them should not exceed the mean height variation on either of them. This was tested and found broadly satisfactory for the lowest, floodplain terrace. It is impossible to test this or a similar hypothesis involving multiples of one side or the other of the inequality defining the existence or otherwise of paired features unless higher flats can be proved to be contemporaneous by non-altimetric means. As a detailed study of terrasiform deposit stratigraphy or lithology was not possible in the time available and as no organic samples suitable for C 14 dating were found there-in, it was not possible to test this criterion further within the field area.

The difficulties and limitations of comparing terrace heights which are believed to be representative and comparable, through the medium of height/distance graphs have been indicated. A new technique for comparing terraces or terrace fragments on an areal basis, by fitting trend surfaces and quantitatively comparing these where a good fit to the initial terrace was obtained, was investigated for three remnants in the Fleurs Castle area. Although only at the earliest stages and requiring more investigation before the advantages of steerable trend surfaces and the correlation technique employed can be fully defined, several interesting aspects emerged from this pilot study. Manifestly miscorrelated fragments were clearly distinguished while it was demonstrated that the use of surfaces fitted to combinations of fragments is inadvisable, whatever the degree of surface employed. In the examples tested, the data distribution pattern did not significantly influence the form of the resultant trend surfaces. The use of the technique is concomitant upon the availability of a very much more detailed height coverage than was normal in this project. Thus its widespread use demands even greater periods spent surveying in the field using conventional methods or requires the introduction of much more rapid yet acceptably accurate techniques. It is hoped to test several of the latter in the future.

Even although detailed correlations, where made, may be erroneous and terrace fragment gradients distorted in important respects, there can be no doubt of the final form of the Tweed valley terrace sequence, a form unprovable except by accurate surveying. The Tweed terraces are made up of several distinct groups of high gradient fragments, interpreted on altimetric and other grounds as ice-proximal outwash. These are truncated at lower levels by the distal sections of younger outwash and present day terraces and terrace fragments. In no case, other than on a purely local scale, could terraces be linked with knickpoints or nickpoints. Equally, only in the zone up to 20 feet above the Lower or extreme Upper Tweed could the terraces be considered as parallel or sub-parallel to the present river and floodplain. It may be that this sequence is peculiar to the Tweed valley but this seems a suspiciously idiographic conclusion. Only by equally detailed work, preferably on an improved altimetric basis in combination with stratigraphical or lithological evidence, can it be shown if the terrace sequences long established in some other parts of Britain contain any of the ice-proximal outwash which would call for reappraisals of the existing evidence.

B. The Pattern of Events in the Deglacierisation of the Tweed Valley

Making due allowance for the difficulties involved in commenting on a regional pattern of deglacierisation from field work restricted to a relatively narrow strip as represented by areas adjacent to the river, it is possible to make a number of generalisations concerning the manner in which ice left the Tweed Valley. From the evidence presented in earlier chapters, it seems likely that foreign ice was either present or caused deflection of Scottish Highland ice into the mouth of the valley at the oldest recognised stages, leading to the possible formation of an ice-dammed lake.

The last deglacierisation in the Berwick to Coldstream area seems to have been typified by downwasting of the large sheet of ice occupying the dished valley between the Lammermuirs and the Cheviots and Fell Sandstone escarpment, resulting in overall thinning and retreat of the ice margin. In front of this mass, ice-proximal high gradient terraces were formed, probably depositional in the main but also formed in part of degraded ice-moulded ridges of till. No evidence is at present available to show if this deglacierisation is that following the Aberdeen - Lammermuir Readvance.

Meltwaters flowing through and along the margins of this ice sheet deposited the kame, kame terrace and kettle hole complex in the Cornhill to Crookham depression, broadly in accordance with Clapperton's postulated two stage drainage hypothesis. Later meltwaters may have split into two courses as evidence exists to suggest a westerly flow to Coldstream and out to the sea via the gorge section of the present Lower Tweed. This gorge, in common with others in the valley was probably cut largely by meltwaters running in, under and in front of the Tweed ice mass.

Little evidence of ice front halts in the general thinning and 'recession' was found as far upvalley as Rutherford, except for some evidence of marginal stagnation. A kame and kettle complex at that spot, related to ice-proximal outwash, is, in association with the stagnation zone at Abbotsford, probably responsible for the broad, impressive low gradient terraces in the Fleurs Castle area and also probably for many of the similar but smaller fragments farther down-valley. The location of the phenomena at Abbotsford is largely explicable in terms of the sudden opening-out of the Tweed valley, in combination with the presence of meltwaters from the southeast and southward-draining Gala and Allan water valleys. It may be that the highest of the kame terraces at Rink Farm, one and three quarter miles upstream from Abbotsford, is related to one stage of the proglacial, ice-proximal outwash which commences near the latter spot.

The long still-stand of the ice front demonstrated in the Ashiesteel area where the ice was confined to a single, deep and steep-sided valley, probably active in all but marginal areas,is difficult to explain on topographic grounds and must therefore be assigned to climatic factors. It seems best, therefore, to postulate a renewed cooler spell to provide for the stabilisation of the ice front while several terraces were formed in front of it.

Following this, little evidence of stabilisation of the ice front is known until the Stobo area, where an unresolved situation concerning the relationship between terraces in the Lyne and Tweed valleys was encountered. The most favoured hypothesis to explain the pattern of these phenomena and the considerable amounts of sand and gravel underlying them is that they were built up by meltwaters from downwasting ice in both valleys. Active ice is believed to have existed in the Tweed valley while that in the Lyne is presumed to have been dead and quickly decaying. The complete rupture of the dead ice barrier in the Lyne by meltwaters impounded in part of the Midland Valley and the rock-defended nature of the Lyne terraces led to the latter being virtually the only remaining evidence of ice presence in this valley, all ice-contact deposits and other terraces being destroyed or buried. It may be, as has been suggested, that this occurred at the end of the Perth Readvance but of this no proof is known to exist. All that can be stated with confidence is that here there is evidence of a prolonged stabilisation of the Tweed ice front, due in part possibly to the change in the Tweed valley width at this point.

Virtually nothing other than the floodplain terrace is known to succeed this proglacial complex as far upvalley as Drumelzier. At this location, clear evidence exists to show that a lobe of Tweed ice protruded out into the combined Biggar and Tweed valleys while the Biggar and Holm Water valleys were probably largely ice-free, the latter receiving meltwaters from the Tweed valley via the low col to the south of Rachan Hill. How much the obvious topographic influence of a dramatic broadening of the valley cross section is responsible for this long-lasting ice in the Tweed valley and what part renewed climatic deterioration played, if any, is as yet unknown for this stage. It may be significant, however, that northeastern trending valleys, 'draining' away from the centres of ice dispersion and therefore always containing thicker ice upvalley seem in certain cases (e.g. Teviot/Tweed and Tweed/Biggar junctions) to have been ice-filled when other adjacent valleys were at least in part ice-free.

The final halt stage in the disappearance of ice from the Tweed Valley is that responsible for ice-proximal outwash in seven north-east, north or northwest trending tributary valleys of the Upper Tweed. These are those containing the Kingledores, Menzion, Hawkshaw, Fingland and Glencraigie Burns and the Talla and Fruid Waters. As at Stobo, at least two possibilities exist in the manner in which this proglacial outwash may have been formed. The suite of terraces and terrace fragments, the surface expression of the outwash, apparently unrelated in the main to events in the main Tweed valley, can be interpreted as a series of flats of different ages due to the retreat of ice into the tributary valleys or, in most cases, as the synchronous outwash from a readvance of valley glaciers. Whatever the reason for the features being at these locations, there seems little doubt that they extended across the main valley opposite their point of issue, then continued down-Tweed, merging with comparable features as their down-valley gradients diminished.

Of all conclusions to be drawn from terraces, those concerning contemporary sea levels are most likely to be in error. On the evidence available, however, it seems possible that the relative sea level at a time when the ice front was between Berwick and Coldstream was relatively low, perhaps 60 feet or more below present. By the time the ice front was in the Rutherford-Abbotsford area relative sea level seems to have risen to some 10 - 15 feet above the present value. Since the last complete deglacierisation of the Tweed Valley, no substantial variations in the vertical position of most parts of the River Tweed are believed to have occurred.

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Appendix I (a)   Levelled spot heights on terrace fragments.

The following 10,700 spot levels were obtained using a Hilger and Watts Autoset level and staff, traversing from and to Ordnance Survey bench marks as described in Chapter 3. The maximal permitted closing error was 0.5 feet and all errors were distributed throughout the traverse. Heights are listed under each fragment in the following format which is repeated twice across each page:

8 Figure National Grid Reference	Height (in feet)	Height (in metres)

In all cases the terrace fragment heights fall within the 100 Kilometre square NT; heights, except where followed by L(= Liverpool datum), are refered to Ordnance Datum or mean sea level at Newlyn. Spaces within each fragment indicate the begining of a second line of heights on the same fragment. All conversions of height from feet to metres were carried out using a conversion factor of 0.3048 and in each case the resultant value was rounded off, correct to the nearest 5 centimetres.

F 1

0553	1755	1106.6	337.20
0551	1760	1103.6	336.40
0550	1765	1099.8	335.20
0554	1767	1099.3	335.05
0549	1769	1090.8	332.50
0550	1773	1089.0	331.95
0549	1777	1088.8	331.85
0550	1780	1086.4	331.15
0547	1783	1081.5	329.65
0562	1766	1105.1	336.85
0558	1768	1100.8	335.50
0555	1771	1095.8	334.00
0552	1774	1091.5	332.70

F 2

0527	1752	1099.1	335.00
0531	1754	1097.0	334.35
0533	1751	1096.3	334.15

F 3

0549	1755	1072.6	326.95
0547	1760	1072.5	326.90
0544	1764	1070.2	326.20
0542	1768	1067.9	325.50
0540	1773	1066.5	325.05
0543	1774	1067.0	325.20
0539	1778	1065.5	324.75
0538	1783	1063.0	324.00
0538	1788	1061.8	323.65

F 4

0545	1749	1084.1	330.45
0543	1753	1082.5	329.95
0540	1756	1080.3	329.30
0535	1758	1079.9	329.15

F 5

0556	1778	1079.3	328.95
0554	1783	1076.2	328.05
0552	1788	1073.0	327.05
0550	1793	1070.0	326.15
0547	1797	1066.5	325.05
0543	1795	1065.2	324.65
0539	1793	1063.2	324.05
0539	1798	1061.0	323.40

F 6

0548	1750	1074.8	327.60
0546	1755	1073.5	327.20
0544	1759	1072.3	326.85
0541	1763	1071.4	326.55
0538	1760	1071.5	326.60
0528	1759	1074.4	327.50
0532	1762	1072.4	326.85
0535	1766	1069.6	326.00
0538	1770	1066.6	325.10
0537	1775	1065.5	324.75
0536	1780	1063.3	324.10
0535	1785	1060.9	323.35
0530	1785	1060.6	323.25
0534	1790	1059.7	323.00
0534	1795	1057.8	322.40
0534	1800	1056.7	322.10
0533	1804	1055.0	321.55
0532	1809	1052.7	320.85

F 7

0537	1788	1059.4	322.90
0537	1793	1057.7	322.40
0537	1797	1056.3	321.95
0537	1802	1054.4	321.40
0539	1806	1053.6	321.15
0540	1811	1053.0	320.95
0540	1816	1050.9	320.30

F 10

0532	1813	1060.4	323.20
0533	1816	1059.3	322.85

F 11

0547	1813	1050.9	320.30
0546	1818	1051.2	320.40
0551	1820	1048.9	319.70

F 12

0535	1816	1052.8	320.90
0536	1821	1050.6	320.20
0538	1824	1048.5	319.60
0539	1828	1047.8	319.35
0539	1833	1046.5	318.95
0538	1838	1044.8	318.45

F 13

0545	1820	1045.0	318.50
0548	1823	1042.3	317.70
0550	1828	1040.7	317.20
0551	1833	1039.0	316.70
0550	1838	1036.7	316.00
0555	1838	1036.8	316.00
0549	1843	1035.2	315.55
0549	1848	1033.4	315.00

0548	1853	1032.2	314.60

F 14

0541	1820	1044.1	318.25
0544	1824	1043.2	317.95
0545	1830	1041.5	317.45
0544	1835	1039.6	316.85
0543	1839	1037.8	316.30

F 15

0553	1849	1034.9	315.45
0551	1853	1034.1	315.20
0549	1857	1033.6	315.05

F 16

0537	1841	1041.5	317.45
0537	1846	1040.8	317.25
0536	1850	1039.0	316.70
0534	1854	1038.7	316.60
0536	1858	1035.9	315.75
0540	1860	1035.0	315.45

F 19

0550	1883	1025.9	312.70
0548	1887	1024.1	312.15
0547	1891	1022.5	311.65
0547	1895	1021.7	311.40
0546	1899	1020.6	311.10
0545	1903	1019.6	310.75
0544	1908	1016.4	309.80
0543	1912	1015.4	309.50
0542	1917	1013.8	309.00
0543	1922	1012.6	308.65
0547	1922	1011.8	308.40
0544	1926	1011.3	308.25
0546	1930	1009.5	307.70
0547	1933	1008.5	307.40

F 20

0540	1863	1035.3	315.55
0542	1867	1033.5	315.00
0545	1871	1030.7	314.15
0544	1875	1030.9	314.20
0543	1879	1029.1	315.65
0541	1883	1027.9	313.30

F 21

0554	1932	1038.8	316.65

F 22

0524	1866	1061.4	323.50
0525	1871	1060.2	323.15
0524	1876	1059.2	322.85

F 23

0563	1923	1076.2	328.05
0566	1926	1076.4	328.10
0565	1929	1077.9	328.55

F 24

0550	1876	1026.0	312.70
0549	1881	1025.3	312.50
0548	1886	1023.4	311.95
0546	1890	1021.9	311.50
0544	1895	1020.1	310.95
0542	1899	1018.8	310.55
0540	1904	1017.6	310.15
0539	1908	1016.1	319.70
0537	1913	1015.1	309.40
0536	1918	1014.2	309.15

F 25

0552	1945	1031.4	314.35
0557	1943	1032.9	314.85
0561	1940	1037.9	316.35
0554	1950	1027.7	313.25
0556	1955	1026.0	312.70
0558	1960	1023.8	312.05
0560	1965	1021.6	311.40
0561	1969	1020.1	310.95

F 26

0525	1898	1051.7	320.55
0529	1900	1046.1	318.85
0530	1896	1045.3	318.60
0533	1901	1042.9	317.90

F 27

0550	1945	1005.2	306.40
0549	1950	1004.2	306.10
0549	1955	1004.6	306.20
0548	1960	1003.8	305.95
0549	1965	1001.4	305.25
0551	1968	1000.7	305.00
0556	1971	999.1	304.55
0560	1974	998.6	304.35
0561	1982	996.8	303.80
0560	1986	996.3	303.65
0558	1989	994.8	303.20
0556	1993	993.0	302.65
0560	1994	992.5	302.50
0555	1998	992.1	302.40
0556	2002	990.0	301.75
0561	2004	990.7	301.95

0564	2008	991.1	302.10
0566	2013	984.5	300.10

F 28

0535	1898	1029.7	313.85
0537	1903	1028.4	313.45
0537	1908	1027.5	313.20
0534	1906	1027.8	313.25

F 29

0566	2035	979.4	298.50
0565	2039	979.3	298.50
0565	2044	977.3	297.90
0565	2049	976.4	297.60
0565	2054	974.4	297.00
0564	2058	973.0	296.55
0563	2063	971.1	296.00
0563	2068	971.1	296.00
0564	2073	969.4	295.45
0565	2078	966.3	294.55
0567	2083	965.7	294.35
0570	2087	964.3	293.90
0572	2092	962.5	293.35

F 30

0537	1926	1012.0	308.45
0539	1930	1010.8	308.10
0542	1934	1009.5	307.70
0544	1938	1006.8	306.85
0545	1942	1006.2	306.70
0540	1943	1005.8	306.55
0546	1948	1003.2	305.80
0545	1953	1001.4	305.25
0545	1957	1000.9	305.05
0546	1916	999.5	304.65
0547	1966	999.3	304.60
0550	1970	997.6	304.05
0553	1974	996.5	303.75
0549	1975	996.4	303.70
0555	1979	994.6	303.15
0554	1984	993.1	302.70
0552	1988	992.2	302.40

F 32

0550	1977	998.5	304.35
0551	1981	999.2	304.55
0550	1985	1000.3	304.90

F 33

0579	2111	959.3	292.40
0581	2115	958.9	292.25
0583	2119	958.0	292.00
0585	2122	956.3	291.50
0589	2123	953.9	290.75
0593	2125	952.8	290.40

F 34

0548	2002	1021.0	311.20
0550	2006	1020.3	311.00
0551	2010	1018.1	310.30
0546	2011	1019.0	310.60
0553	2014	1016.8	309.90
0554	2019	1016.3	309.75

F 35

0613	2145	953.0	290.45
0616	2146	951.5	290.00

F 36

0549	2023	1001.5	305.25
0555	2026	994.6	303.15
0556	2030	992.6	302.55
0555	2034	990.1	301.80

F 37

0611	2145	948.7	289.15
0614	2148	946.9	288.60
0617	2151	944.4	287.85
0619	2148	946.3	288.45
0621	2153	943.7	287.65
0625	2154	941.7	287.05
0629	2156	940.6	286.70
0633	2158	939.0	286.20

F 39

0626	2150	946.6	288.50
0630	2153	944.7	287.95
0633	2156	943.6	287.60
0637	2159	939.6	286.40
0640	2162	938.4	286.00
0644	2165	936.9	285.55
0647	2168	933.3	284.45

F 40

0561	1913	988.8	301.40
0563	1917	987.1	300.85
0564	1921	985.4	300.35
0563	1926	986.0	300.55
0561	1930	983.8	299.85
0560	1934	981.0	299.00
0560	1938	979.8	298.65
0556	1938	981.0	299.00
0562	1938	979.4	298.50
0560	1943	979.3	298.50

0560	1947	976.7	297.70
0560	1952	976.1	297.50
0560	1957	972.6	296.45
0559	1961	970.1	295.70
0559	1966	968.5	295.20
0558	1970	967.1	294.75
0559	1974	966.7	294.65
0560	1978	966.0	294.45
0562	1982	963.9	293.80
0564	1986	962.8	293.45
0567	1990	961.3	293.00
0569	1994	959.6	292.50
0571	1998	960.5	292.75
0572	2002	958.5	292.15
0572	2007	958.2	292.10

F 41

0670	2168	975.9	297.45
0668	2171	972.2	296.35
0666	2174	968.5	295.20
0666	2178	966.6	294.60
0668	2182	965.6	294.30
0657	2171	972.8	296.50

F 42

0586	2126	954.5	290.95
0591	2128	953.6	290.65
0595	2130	951.7	290.10
0600	2132	950.7	289.75
0604	2134	949.8	289.50
0605	2138	949.1	289.30
0607	2143	946.6	288.50
0609	2147	945.0	288.05

F 43

0683	2163	989.9	301.70
0683	2167	983.6	299.80
0682	2171	974.9	297.15

F 44

0623	2156	939.8	286.45
0628	2158	937.4	285.70
0632	2160	935.2	285.05
0636	2163	933.4	284.50
0640	2166	932.4	284.20

F 45

0650	2168	940.6	286.70
0652	2171	939.2	286.25

F 46

0640	2168	939.9	286.50
0645	2170	937.7	285.80
0649	2173	938.2	285.95
0652	2177	938.0	285.90
0655	2181	938.3	286.00

F 47

0680	2168	964.9	294.10
0679	2172	960.0	292.60
0677	2176	955.7	291.30
0676	2180	952.8	290.40
0675	2183	950.4	289.70
0672	2188	948.8	289.20
0675	2190	947.6	288.85

F 48

0673	2192	927.9	282.80
0677	2194	926.4	282.35
0681	2197	924.7	281.85
0685	2199	922.5	281.20
0689	2201	920.2	280.50
0691	2206	918.2	279.85
0693	2210	917.1	279.55

F 49

0687	2181	937.7	285.80
0684	2184	936.1	285.30
0682	2187	932.5	284.25
0680	2191	929.1	283.20

F 50

0704	2218	918.8	280.05
0709	2219	917.0	279.50
0714	2220	915.8	279.15
0718	2222	914.6	278.75
0722	2224	913.2	278.35
0726	2226	911.6	277.85
0730	2228	909.5	277.20
0734	2231	908.3	276.85
0738	2235	906.6	276.35
0741	2238	905.2	275.90
0745	2241	904.3	275.65
0748	2245	903.7	275.45
0751	2248	899.9	274.30
0748	2252	899.7	274.25
0753	2251	897.5	273.55
0752	2256	896.0	273.10
0750	2260	894.2	272.55

F 51

0684	2193	944.1	287.75
0688	2195	946.2	288.40
0692	2197	945.7	288.25
0696	2199	944.5	287.90

0699	2196	944.3	287.80
0694	2202	944.2	287.80
0699	2202	942.6	287.30
0702	2205	938.0	285.90
0705	2208	935.9	285.25

F 52

0735	2230	905.8	276.10
0739	2233	903.8	275.50
0742	2236	902.1	274.95
0745	2240	900.8	274.55

F 53

0712	2207	930.9	283.75
0717	2209	927.4	282.65

F 54

0765	2276	887.5	270.50
0769	2277	886.4	270.15
0774	2278	885.3	269.85
0778	2279	884.3	269.55
0782	2281	881.8	268.75

F 55

0752	2220	950.8	289.80
0750	2223	949.2	289.30
0747	2225	946.9	288.60
0745	2228	943.7	287.65
0741	2226	943.3	287.50
0738	2224	942.9	287.40
0735	2221	946.6	288.50

F 56

0787	2294	932.4	284.20
0791	2297	930.1	283.50
0794	2300	927.2	282.60

F 57

0761	2212	950.0	289.55
0760	2215	947.7	288.85
0758	2218	946.3	288.45
0755	2222	941.5	286.95
0754	2225	938.6	286.10
0752	2228	937.1	285.65
0750	2232	935.5	285.15
0751	2237	933.5	284.55

F 58

0795	2287	884.0	269.45
0797	2291	882.9	269.10
0800	2294	880.3	268.30
0803	2297	877.6	267.50
0806	2300	876.7	267.20

F 59

0755	2240	909.6	277.25
0752	2242	908.2	276.80
0754	2245	904.3	275.65

F 60

0812	2310	886.2	270.10
0816	2312	884.7	269.65
0820	2315	882.4	268.95
0824	2317	880.6	268.40
0828	2319	878.6	267.80
0832	2321	876.8	267.25
0836	2323	873.6	266.25
0840	2325	873.2	266.15
0843	2328	871.3	265.55
0846	2330	870.0	265.20

F 61

0708	2112	919.4	280.25
0703	2212	917.5	279.65
0707	2213	915.3	279.00
0712	2215	914.1	278.60
0717	2217	912.9	278.25
0722	2221	912.0	278.00
0727	2223	911.1	277.70
0731	2225	910.3	277.45
0735	2227	909.3	277.15
0738	2229	907.4	276.60
0741	2231	907.0	276.45
0744	2234	905.7	276.05
0747	2237	903.8	275.50
0750	2240	901.5	274.80

F 62

0825	2315	871.0	265.50

F 63

0762	2235	939.6	286.40
0760	2238	938.7	286.10
0758	2242	936.1	285.30
0755	2246	935.8	285.25
0757	2247	932.9	284.35
0760	2249	930.7	283.70
0763	2252	928.3	282.95
0765	2249	930.4	283.60
0766	2255	926.5	282.40

0770	2258	922.7	281.25
0773	2261	921.1	280.75
0777	2263	921.1	280.75
0781	2265	919.2	280.15
0784	2268	918.4	279.95
0787	2270	919.3	280.20
0790	2268	919.1	280.15
0791	2272	919.4	280.25
0794	2274	918.6	280.00
0798	2276	919.0	280.10
0802	2278	917.3	279.60

F 64

0845	2327	862.4	262.85
0848	2329	863.2	263.10
0852	2331	863.2	263.10
0856	2333	861.7	262.65
0859	2336	860.1	262.15
0863	2338	858.5	261.65
0866	2341	855.5	260.75
0869	2345	854.5	260.45
0870	2348	854.0	260.30
0871	2352	852.3	259.80
0872	2356	851.4	259.50
0873	2359	850.3	259.15

F 65

0754	2260	898.0	273.70
0752	2264	899.0	274.00
0753	2268	899.5	274.15
0756	2270	898.6	273.90
0760	2271	898.4	273.85
0764	2272	897.3	273.50
0768	2273	895.5	272.95
0772	2274	893.2	272.25

F 66

0854	2331	856.9	261.20
0859	2331	855.7	260.80
0864	2332	855.1	260.65
0868	2333	853.7	260.20
0872	2334	852.6	259.85
0873	2336	852.7	259.90
0870	2338	850.5	259.25
0875	2339	850.5	259.25
0875	2343	848.8	258.70
0874	2347	847.1	258.20
0873	2351	846.1	257.90

F 67

0756	2265	906.9	276.40
0760	2267	906.6	276.35
0765	2267	904.6	275.70

F 68a

0856	2324	854.5	260.45
0861	2324	852.5	259.85
0866	2324	851.1	259.40
0871	2325	850.6	259.25
0876	2326	850.1	259.10
0880	2327	848.3	258.55
0883	2331	848.3	258.55
0880	2335	847.4	258.30
0877	2337	845.7	257.75
0883	2336	847.0	258.15
0881	2340	845.7	257.75
0880	2345	844.2	257.30
0879	2349	843.3	257.05

F 68b

0870	2322	849.8	259.00
0875	2323	848.7	258.70
0880	2323	847.5	258.30
0884	2326	847.2	258.25
0886	2329	845.9	257.85

F 68c

0881	2350	841.1	256.35
0879	2354	838.9	255.70
0876	2358	838.7	255.65
0876	2362	838.0	255.40

F 69

0773	2271	901.3	274.70
0776	2273	899.9	274.30

F 70

0863	2347	870.4	265.30
0866	2350	869.0	264.85
0868	2354	867.6	264.45

F 71

0779	2277	891.1	271.60
0783	2278	887.3	270.45
0786	2280	885.3	269.85

F 72

0886	2363	838.0	255.40
0889	2367	836.0	254.80
0892	2371	835.1	254.55
0895	2375	834.3	254.30

0898	2379	832.8	253.85
0902	2382	829.9	252.95
0905	2385	827.8	252.30
0909	2389	826.7	252.00
0912	2393	825.2	251.50
0916	2397	823.6	251.05
0920	2400	822.8	250.80

F 73

0789	2278	909.2	277.10
0791	2282	907.6	276.65

F 74

0921	2403	837.0	255.10
0923	2405	838.6	255.60
0926	2408	836.5	254.95

F 75

0794	2282	897.2	273.45
0799	2282	896.8	273.35
0801	2285	894.7	272.70

F 76

0930	2403	822.3	250.65
0935	2403	820.5	250.10
0940	2404	820.0	249.95
0944	2406	819.3	249.70
0948	2408	818.3	249.40
0953	2410	817.6	249.20
0956	2413	816.2	248.80
0959	2417	814.3	248.20
0956	2419	815.3	248.50
0954	2422	814.9	248.40
0962	2420	812.7	247.70
0964	2424	811.1	247.20
0959	2423	814.0	248.10
0963	2426	814.5	248.25
0966	2430	811.7	247.40
0970	2432	810.7	247.10
0974	2435	809.9	246.85

F 77

0798	2285	882.4	268.95

F 78

0946	2423	845.2	257.60
0950	2425	843.2	257.00
0953	2427	840.8	256.30

F 79

0808	2292	880.7	268.45

F 80

0951	2430	846.8	258.10
0954	2434	845.6	257.75

F 81

0819	2302	876.7	267.20
0823	2304	874.8	266.65
0827	2306	869.8	265.10
0826	2310	869.5	265.00
0828	2302	871.2	265.55
0831	2308	868.4	264.70

F 82

0963	2437	821.3	250.35
0967	2438	820.3	250.05

F 83

0827	2312	867.0	264.25
0830	2314	865.0	263.65

F 84

0986	2450	795.7	242.55
0989	2454	794.7	242.20
0992	2457	793.9	242.00
0995	2460	792.8	241.65

F 85

0834	2318	871.3	265.55
0839	2319	868.5	264.70
0844	2320	867.6	264.45

F 86

0982	2453	813.2	247.85
0985	2456	812.5	247.65
0988	2459	811.3	247.30
0992	2462	811.8	247.45
0990	2464	810.3	247.00
0995	2466	807.5	246.15

F 87

0836	2314	877.0	267.30
0838	2311	878.4	267.75

0840	2316	875.1	266.75
0845	2317	873.4	266.20
0849	2316	872.8	266.05

F 88

0984	2462	833.9	254.15
0987	2465	833.4	254.00

F 89

0853	2313	903.3	275.35
0856	2311	901.6	274.80

F 90

1018	2495	813.2	247.85
1023	2496	813.2	247.85
1026	2498	813.7	248.00
1030	2500	812.4	247.60
1032	2503	810.8	247.15
1035	2507	810.5	247.05
1038	2510	808.8	246.50
1041	2514	808.4	246.40
1035	2516	809.8	246.85
1038	2517	809.1	246.60
1044	2517	809.1	246.60
1044	2521	807.7	246.20
1046	2525	806.3	245.75
1047	2530	804.7	245.25
1048	2535	802.7	244.65
1052	2538	799.3	243.65
1054	2542	797.3	243.00
1057	2546	796.7	242.85
1059	2550	796.5	242.75
1061	2555	795.4	242.45
1067	2562	795.5	242.45

F 91

0856	2254	934.9	284.95
0856	2263	932.5	284.25
0856	2268	929.6	283.35
0857	2272	925.6	282.10
0857	2277	922.5	281.20
0857	2282	917.9	279.80
0858	2287	917.1	279.55
0858	2292	916.3	279.30
0858	2297	919.8	280.35
0858	2301	920.9	280.70
0854	2295	919.1	280.15
0850	2293	917.8	279.75
0846	2291	917.3	279.60
0842	2289	917.7	279.70
0837	2287	918.8	280.05
0833	2285	921.0	280.70

0829	2283	922.7	281.25
0825	2281	922.3	281.10
0821	2279	922.5	281.20
0817	2277	920.8	280.65
0813	2274	920.5	280.55
0809	2272	919.2	280.15
0805	2270	917.3	279.60

F 92

1016	2484	800.3	243.95
1020	2488	799.1	243.55
1023	2492	799.2	243.60
1026	2488	797.9	243.20
1030	2491	796.5	242.75

F 93

0865	2308	864.9	263.60
0862	2311	864.0	263.35
0859	2314	862.6	262.90
0856	2316	861.0	262.45
0850	2318	861.3	262.50

F 94

1031	2476	783.4	238.80
1033	2480	782.7	238.55
1035	2484	781.3	238.15
1037	2489	782.0	238.35
1038	2494	779.5	237.60
1040	2499	778.7	237.35
1042	2502	778.1	237.15

F 95

0865	2312	859.5	262.00
0862	2314	858.7	261.75
0859	2317	857.6	261.40
0856	2320	857.3	261.30
0852	2321	858.1	261.55
0848	2321	857.0	261.20

F 96

1033	2495	794.1	242.05
1036	2498	795.9	242.60
1037	2502	792.6	241.60
1041	2505	788.8	240.45
1045	2508	786.7	239.80
1048	2511	785.8	239.50
1050	2512	785.2	239.35
1052	2516	784.7	239.20
1055	2520	781.4	238.15
1056	2523	781.2	238.10
1058	2528	780.6	237.95

1054	2529	780.8	238.00
1016	2531	778.6	237.30
1064	2535	775.1	236.25
1066	2539	773.8	235.85
1068	2543	772.3	235.40
1070	2548	772.4	235.45

F 97

0861	2316	853.1	260.00
0860	2319	852.4	259.80
0863	2320	851.4	259.50
0866	2319	850.2	259.15

F 98

1052	2508	776.2	236.60
1055	2510	775.8	236.45
1059	2512	774.7	236.15
1061	2516	773.3	235.70
1062	2519	773.0	235.60
1064	2523	772.4	235.45

F 99

0874	2303	871.7	265.70
0872	2308	868.9	264.85
0869	2312	868.2	264.65
0866	2315	866.0	263.95
0862	2317	866.4	264.10
0867	2317	862.9	263.00
0872	2318	861.1	262.45
0877	2319	858.9	261.80
0881	2320	859.3	261.90

F 100

1057	2507	773.3	235.70
1061	2510	772.8	235.55
1062	2514	771.5	235.15

F 101

0880	2308	894.9	272.75
0881	2313	894.6	272.65
0883	2317	890.5	271.40
0890	2319	892.6	272.05
0892	2323	891.6	271.75
0894	2319	889.0	270.95
0895	2326	890.8	271.50

F 102

1073	2539	770.8	234.95
1075	2543	769.0	234.40
1078	2547	768.3	234.20
1082	2550	766.4	233.60
1085	2554	765.7	233.40
1086	2558	764.3	232.95
1090	2556	763.3	232.65
1082	2560	763.8	232.80
1078	2562	761.9	232.25
1085	2563	762.6	232.45
1084	2568	761.4	232.05
1082	2572	759.9	231.60

F 103

0908	2325	882.3	268.95
0905	2328	879.1	267.95
0902	2330	877.9	267.60
0896	2337	874.2	266.45
0892	2340	875.3	266.80

0938	2339	868.1	264.60
0942	2342	867.7	264.45
0946	2345	868.9	264.85
0900	2348	870.9	265.45
0897	2351	871.3	265.55

F 104

1083	2586	759.2	231.40
1085	2591	759.8	231.60
1087	2596	758.6	231.20
1090	2600	758.1	231.05
1092	2605	756.2	230.50
1094	2610	755.3	230.20
1098	2613	754.6	230.00
1102	2617	753.6	229.70
1106	2619	753.3	229.60
1111	2621	753.3	229.60
1115	2625	751.9	229.20
1118	2629	750.6	228.80
1121	2633	749.7	228.50
1124	2638	748.4	228.10
1125	2642	745.6	227.25
1120	2643	746.2	227.45
1115	2644	748.2	228.05
1130	2641	744.3	226.85
1131	2645	745.4	227.20
1131	2650	744.9	227.05
1132	2655	742.7	226.35
1131	2660	743.6	226.65
1130	2665	741.3	225.95
1130	2670	740.3	225.65
1129	2675	739.5	225.40
1128	2680	739.2	225.30
1127	2685	737.9	224.90
1126	2690	735.9	224.30

1125	2695	736.3	224.40
1125	2700	735.1	224.05

F 105

0924	2323	874.7	266.60
0922	2326	872.2	265.85
0922	2331	869.1	264.90

F 106

1114	2740	726.7	221.50
1113	2744	726.0	221.30
1112	2747	725.8	221.20
1111	2751	725.4	221.10
1110	2755	724.6	220.85
1105	2755	724.3	220.75
1109	2760	723.6	220.55
1108	2764	722.5	220.20
1107	2769	721.3	219.85
1106	2773	720.2	219.50
1105	2777	719.9	219.45
1103	2781	720.0	219.45
1103	2785	721.0	219.75
1103	2790	719.6	219.35
1103	2796	718.9	219.10
1103	2801	717.8	218.80
1103	2806	717.3	218.65
1104	2810	716.3	218.35
1103	2814	715.8	218.20
1098	2812	715.4	218.05
1094	2810	716.4	218.35
1101	2819	714.7	217.85
1099	2823	714.7	217.85
1097	2828	713.1	217.35
1096	2832	712.0	217.00
1094	2835	711.4	216.85
1093	2839	710.0	216.40
1092	2844	709.1	216.15
1091	2848	708.6	216.00

F 107

0927	2325	878.6	267.80
0926	2329	874.2	266.45
0925	2333	871.9	265.75
0924	2336	869.6	265.05

F 108

1102	2788	741.1	225.90
1100	2792	740.0	225.55

F 109

0916	2339	861.7	262.65
0914	2342	859.8	262.05
0912	2345	855.6	260.80

F 111

0893	2353	858.8	261.75
0896	2355	857.1	261.25
0900	2357	856.2	260.95

F 112

1055	2822	757.4	230.85
1059	2822	756.4	230.55
1063	2823	753.7	229.75
1067	2824	751.6	229.10
1071	2825	749.7	228.50
1071	2829	748.4	228.10
1071	2821	750.0	228.60
1072	2817	750.4	228.70
1072	2813	749.9	228.55
1075	2826	747.7	227.90
1079	2827	745.2	227.15
1083	2829	742.4	226.30
1087	2830	739.6	225.45

F 113

0887	2351	848.6	258.65
0886	2355	847.1	258.20
0888	2358	844.5	257.40
0892	2363	843.5	257.10
0893	2359	844.3	257.35
0895	2365	840.9	256.30

F 114

1077	2822	755.4	230.25
1081	2823	753.0	229.50
1084	2824	752.8	229.45

F 115

0883	2353	840.1	256.05
0881	2357	839.9	256.00
0882	2361	839.4	255.85
0885	2359	837.3	255.20

F 116

1075	2844	719.5	219.30
1079	2846	716.3	218.35
1083	2848	714.7	217.85

F 117

0921	2350	861.4	262.55

0923	2354	859.5	262.00
0926	2357	857.1	261.25
0929	2360	854.8	260.55
0932	2363	854.5	260.45
0935	2366	854.0	260.30

F 118

1064	2837	733.2	223.50
1068	2839	731.1	222.85
1072	2840	727.5	221.75

F 119

0902	2372	837.8	255.35
0905	2375	837.5	255.25
0908	2379	837.3	255.20
0910	2375	837.7	255.35
0913	2372	839.2	255.80
0915	2368	840.0	256.05
0912	2380	835.8	254.75
0916	2382	834.6	254.40

F 120

1080	2849	722.3	220.15
1082	2853	720.6	219.65
1084	2856	719.4	219.25

F 121

0912	2386	832.6	253.80
0915	2389	831.1	253.30
0918	2392	830.6	253.15
0922	2394	829.1	252.70
0926	2396	828.0	252.35
0924	2398	829.5	252.85
0927	2392	826.9	252.05
0929	2388	827.0	252.05
0930	2397	826.6	251.95
0933	2398	825.2	251.50
0937	2399	822.4	250.65
0941	2401	821.9	250.50
0945	2402	821.0	250.25
0949	2404	819.5	249.80
0949	2402	821.7	250.45
0953	2404	821.4	250.35
0957	2406	819.5	249.80
0960	2408	817.2	249.10
0963	2411	819.2	249.70
0966	2415	817.5	249.15
0968	2419	812.5	247.65
0969	2423	811.4	247.30
0972	2427	810.6	247.05

F 122

1065	2844	749.4	228.40
1068	2846	746.6	227.55
1071	2849	744.3	226.85
1074	2852	741.2	225.90
1076	2855	738.8	225.20
1079	2858	737.0	224.65
1080	2862	736.1	224.35
1081	2866	734.0	223.70
1081	2870	734.0	223.70

F 124

1070	2861	776.9	236.80
1072	2865	769.6	234.55
1075	2868	763.6	232.75
1076	2870	758.0	231.05
1079	2873	750.5	228.75

F 125

0937	2383	847.4	258.30
0940	2387	847.2	258.25
0945	2393	844.9	257.55
0948	2396	842.9	256.90
0952	2398	840.8	256.30

F 126

1036	2835	846.2	257.90
1040	2837	842.4	256.75
1042	2840	841.1	256.35
1044	2844	837.9	255.40
1047	2847	834.4	254.35
1050	2850	833.6	254.10
1052	2854	831.7	253.50

F 127

0991	2412	863.9	263.30
0987	2413	858.9	261.80
0983	2414	855.3	260.70
0979	2415	852.5	259.85
0976	2412	852.8	259.95
0973	2408	854.0	260.30
0981	2420	852.3	259.80
0975	2417	852.1	259.70

F 129

0994	2418	838.0	255.40
0992	2422	837.3	255.20
0990	2426	835.5	254.65

0983	2430	834.7	254.40
0984	2432	833.5	254.05
0985	2435	831.9	253.55

F 130

1201	3043	674.6	205.60
1203	3047	672.8	205.05
1205	3015	673.3	205.20
1207	3055	670.9	204.50
1209	3058	670.5	204.35
1211	3062	670.6	204.40
1217	3075	669.5	204.05
1220	3078	668.3	203.70
1224	3081	667.8	203.55
1228	3083	666.9	203.25
1233	3084	666.4	203.10
1238	3083	666.0	203.00
1243	3082	664.7	202.60
1248	3082	664.3	202.50
1252	3085	664.0	202.40
1252	3090	663.1	202.10
1250	3094	662.1	201.80
1249	3099	661.9	201.75
1249	3103	661.0	201.45
1250	3109	660.6	201.35
1250	3114	660.4	201.30
1250	3119	659.3	200.95
1245	3119	659.6	201.05
1241	3119	658.4	200.70
1236	3119	657.9	200.55
1232	3118	658.2	200.60
1228	3118	659.8	201.10
1223	3118	660.4	201.30
1219	3117	659.7	201.10
1250	3123	659.7	201.10
1251	3127	658.5	200.70
1252	3131	658.1	200.60
1253	3135	657.0	200.25
1254	3140	655.8	199.90
1255	3144	655.7	199.85
1255	3149	655.6	199.85
1254	3153	654.3	199.45
1253	3158	654.1	199.35
1252	3162	653.1	199.05
1251	3167	652.7	198.95
1250	3171	652.3	198.85
1249	3175	651.9	198.70
1248	3179	651.5	198.60
1246	3183	651.0	198.40
1244	3187	650.5	198.25
1241	3191	649.7	198.05
1239	3195	650.1	198.15
1238	3200	648.3	197.60
1237	3204	648.6	197.70
1237	3209	647.7	197.40
1237	3214	647.4	197.35
1238	3218	647.0	197.20
1239	3223	646.2	196.95
1240	3228	645.9	196.85
1242	3232	646.2	196.95
1238	3232	645.1	196.65
1233	3232	644.8	196.55
1229	3232	643.9	196.25
1224	3232	645.2	196.65
1220	3232	644.9	196.55
1215	3232	644.0	196.30
1241	3237	644.9	196.55
1240	3241	644.4	196.40
1238	3245	644.8	196.55
1236	3249	643.9	196.25
1235	3253	643.0	196.00
1232	3256	643.0	196.00
1230	3260	642.7	195.90
1228	3264	642.1	195.70
1225	3267	642.1	195.70
1223	3271	641.7	195.60
1221	3275	641.3	195.45
1220	3279	640.6	195.25
1218	3283	640.0	195.05
1217	3286	639.7	195.00
1216	3291	639.4	194.90
1215	3295	639.2	194.85
1215	3299	638.1	194.50
1214	3303	637.6	194.35
1220	3316	637.2	194.20
1222	3320	636.3	193.95
1224	3324	636.4	193.95
1226	3328	636.4	193.95
1228	3333	636.2	193.90
1230	3337	635.7	193.75
1231	3341	634.9	193.50
1233	3345	634.2	193.30
1234	3350	633.8	193.20
1236	3354	633.8	193.20
1237	3358	633.0	192.95

F 131

0981	2436	819.2	249.70
0983	2439	818.3	249.40
0985	2442	816.6	248.90

F 132

1186	3032	720.9	219.75
1189	3035	720.4	219.60
1192	3038	714.9	217.90
1194	3042	710.4	216.55

F 133

0987	2446	809.9	246.85
0991	2449	809.3	246.65
0996	2452	808.0	246.30
0999	2453	808.3	246.35
0999	2448	808.4	246.40

F 134

1203	3319	702.7	214.20
1202	3323	702.1	214.00
1201	3327	700.7	213.55

F 135

0996	2427	828.5	252.55
0994	2431	826.7	252.00
0992	2435	825.0	251.45
0992	2440	823.0	250.85
0990	2444	820.9	250.20
0995	2444	820.1	249.95

F 136

1181	3298	771.9	235.30
1179	3302	772.1	235.35
1176	3306	773.0	235.60
1176	3310	770.9	234.95

F 137

1000	2426	811.3	247.30
0999	2430	810.4	247.00
0998	2434	808.7	246.50
0998	2439	807.7	246.20
0998	2444	806.1	245.70

F 138

1190	3320	733.3	223.50
1187	3323	733.1	223.45
1185	3226	732.7	223.35
1183	3330	733.3	223.50
1181	3333	737.5	224.80
1180	3336	740.1	225.60
1178	3333	736.2	224.40
1175	3331	735.9	224.30

F 139

1002	2436	805.3	245.45
1002	2441	802.8	244.70
1003	2445	801.1	244.20
1003	2449	798.3	243.30

F 140

1197	3342	744.2	226.85
1193	3344	747.7	227.90
1189	3345	746.6	227.55
1185	3347	745.6	227.25
1182	3350	748.2	228.05

F 141

1013	2438	795.9	242.60
1015	2440	794.5	242.15
1017	2444	794.2	242.05
1016	2449	792.6	241.60

F 142

1176	3336	751.5	229.05
1172	3339	741.6	226.05
1168	3342	734.9	224.00
1164	3345	731.6	223.00
1167	3348	729.6	222.40
1161	3341	732.5	223.25
1159	3337	729.1	222.25
1160	3348	728.1	221.90
1156	3351	725.3	221.05

F 143

1018	2395	838.8	255.65
1015	2398	839.7	255.95
1013	2402	834.4	254.35
1011	2402	832.1	253.60

F 144

1116	3375	712.8	217.25
1119	3378	711.6	216.90
1121	3382	710.0	216.40
1122	3387	706.9	215.45

F 145

1016	2409	854.5	260.45
1016	2414	853.5	260.15

F 146

1087	3363	722.2	220.15
1089	3364	724.1	220.70
1091	3368	719.9	219.45
1094	3371	718.8	219.10
1097	3375	720.2	219.50
1094	3378	720.1	219.50
1101	3372	719.6	219.35

1100	3378	719.7	219.35
1102	3381	721.9	220.05
1105	3384	723.2	220.45
1107	3388	720.3	219.55
1109	3391	723.5	220.50
1111	3395	721.2	219.80
1113	3398	721.5	219.90
1116	3302	718.7	219.05

F 147

1007	2403	823.3	250.95
1005	2408	821.8	250.50
1004	2413	820.0	249.95
1001	2412	818.5	249.50
1006	2413	819.0	249.65
1004	2418	817.2	249.10
1006	2422	814.3	248.20

F 148

1095	3407	717.8	218.80
1098	3410	716.7	218.45
1101	3408	716.7	218.45
1101	3412	713.7	217.55
1104	3415	709.1	216.15

F 149

1013	2418	823.3	250.95
1014	2423	823.9	251.10

F 150

1154	3395	694.8	211.80
1152	3399	689.8	210.25
1148	3399	691.4	210.75
1152	3403	688.4	209.80
1153	3408	689.0	210.00
1153	3413	685.6	208.95
1153	3417	682.5	208.05
1153	3420	680.0	207.25
1152	3425	676.0	206.05
1149	3421	679.8	207.20
1145	3418	680.2	207.30
1142	3415	681.5	207.70
1150	3429	673.0	205.15
1149	3433	670.2	204.30
1148	3437	666.1	203.05
1146	3441	665.5	202.85

F 151

1010	2422	816.2	248.80
1012	2426	812.2	247.55
10.4	2430	811.6	247.40

F 152

1099	3396	678.3	206.75
1102	3400	676.5	206.20
1105	3403	674.8	205.70
1107	3407	674.1	205.45
1110	3411	672.7	205.05
1113	3415	671.3	204.60
1115	3419	671.2	204.60
1116	3424	670.0	204.20
1117	3429	668.2	203.65
1119	3433	665.7	202.90
1123	3432	665.2	202.75
1126	3430	666.0	203.00
1122	3436	664.2	202.45
1126	3439	663.6	202.25
1130	3442	661.6	201.65
1133	3445	661.0	201.45
1135	3449	658.6	200.75
1138	3453	656.4	200.05
1141	3456	654.3	199.45
1145	3458	653.1	199.05
1149	3460	651.4	198.55
1150	3459	652.4	198.85
1154	3462	649.8	198.05
1158	3465	648.7	197.70
1160	3469	646.8	197.15
1161	3472	645.2	196.65
1163	3476	644.1	196.30
1167	3480	642.6	195.85
1171	3482	641.7	195.60
1175	3483	639.9	195.05
1180	3486	639.2	194.85
1183	3488	638.0	194.45
1187	3490	636.7	194.05
1191	3491	636.2	193.90
1196	3491	635.3	193.65
1200	3492	635.2	193.60
1204	3493	633.0	192.95
1209	3494	632.5	192.80
1211	3489	631.1	192.35
1213	3485	629.3	191.80
1215	3481	628.4	191.55
1218	3478	628.1	191.45
1220	3474	627.7	191.30
1223	3471	628.5	191.55
1214	3493	630.0	192.00
1219	3492	630.1	192.05
1223	3491	628.4	191.55
1227	3490	627.1	191.15
1232	3489	626.5	190.95

F 153

1002	2422	812.2	247.55
1004	2425	809.1	246.60
1007	2428	807.5	246.15

F 154

1119	3442	668.9	203.90
1121	3445	668.9	203.90
1125	3448	668.6	203.80
1128	3452	665.9	202.95
1131	3456	665.0	202.70
1135	3459	664.5	202.55
1138	3462	663.2	202.15
1142	3466	662.3	201.85
1145	3469	662.0	201.80
1148	3471	661.5	201.65
1149	3473	660.1	201.20
1153	3476	658.3	200.65
1156	3480	656.5	200.10
1160	3482	654.8	199.60
1164	3485	654.3	199.45
1166	3488	652.9	199.00
1170	3492	651.0	198.40
1173	3495	649.2	197.90
1173	3499	648.7	197.70
1174	3502	647.7	197.40
1174	3506	646.8	197.15
1174	3510	645.1	196.65
1178	3497	646.2	196.95
1183	3499	644.6	196.45
1188	3501	642.9	195.95
1193	3503	641.9	195.65
1195	3505	641.6	195.55

F 155

1002	2427	801.0	244.15
1003	2432	799.8	243.80
1006	2435	798.7	243.45
1011	2435	796.8	242.85

F 156

1150	3448	661.0	201.45
1153	3449	659.8	201.10
1152	3452	660.8	201.40
1156	3456	659.2	200.90
1160	3458	656.8	200.20
1164	3460	654.8	199.60
1168	3462	653.2	199.10
1172	3464	652.2	198.80
1174	3460	651.6	198.60
1175	3455	654.0	199.35
1176	3451	655.4	199.75
1178	3461	652.7	199.95
1182	3462	651.2	198.50
1186	3461	649.7	198.05
1191	3460	648.7	197.70
1195	3458	647.6	197.40
1199	3457	646.7	197.10
1203	3455	645.2	196.65
1207	3452	644.3	196.40
1211	3450	644.2	196.35
1215	3448	644.2	196.35
1217	3447	649.1	197.85
1225	3445	648.6	197.70
1230	3445	649.6	198.00
1235	3444	651.7	198.65
1239	3444	653.8	199.30
1238	3440	654.9	199.60
1236	3436	655.9	199.90
1235	3432	656.8	200.20

F 157

1031	2409	804.5	345.20
1033	2413	802.0	244.45
1038	2415	800.6	244.00

F 158

1135	3468	676.3	206.15
1138	3472	676.8	206.30
1140	3476	676.8	206.30
1142	3480	675.1	205.75
1144	3481	671.3	204.60
1147	3485	665.5	202.85
1149	3488	665.9	202.95

F 159

1025	2458	808.3	246.35

F 161

1020	2460	787.6	240.05
1022	2464	785.2	239.35
1024	2468	785.3	239.35
1026	2472	784.7	239.20
1000	2465	790.4	240.90
1000	2468	790.0	240.80
1007	2471	788.6	240.35
1012	2473	787.1	239.90
1017	2473	786.4	239.70
1022	2473	786.1	239.60

F 162

1195	3551	629.3	191.80
1197	3554	628.1	191.45
1200	3557	627.8	191.35
1202	3560	627.7	191.30
1205	3563	628.4	191.55

1207	3566	627.7	191.30
1197	3548	628.2	191.50
1200	3546	627.8	191.35
1203	3544	626.4	190.95
1206	3542	626.0	190.80
1209	3539	625.9	190.75
1212	3536	625.9	190.75
1215	3533	625.5	190.65
1218	3530	625.6	190.70
1221	3526	625.6	190.70

F 163

1040	2483	782.4	238.50
1042	2488	782.3	238.45
1043	2493	780.7	237.95
1044	2497	779.4	237.55
1045	2501	778.1	237.15
1046	2503	777.5	237.00
1049	2505	777.0	236.85
1054	2504	774.9	236.20

F 164

1247	3488	623.3	190.00
1251	3484	622.8	189.85
1256	3482	622.7	189.80
1261	3480	622.8	189.85
1267	3477	622.3	189.70
1266	3482	621.5	189.45
1271	3480	622.3	189.70
1275	3481	622.4	189.70
1272	3490	619.1	188.70
1277	3491	618.7	188.60
1282	3492	617.7	188.25
1286	3494	617.9	188.35
1290	3496	617.7	188.25
1294	3499	617.0	188.05
1298	3501	616.8	188.00
1301	3505	615.8	187.70
1304	3509	615.2	187.50
1308	35.2	614.7	187.35
1311	3515	613.6	187.05
1315	3518	613.3	186.95
1319	3521	612.9	186.80
1322	3524	613.1	186.85

F 165

1052	2491	783.7	238.85
1053	2495	784.6	239.15
1053	2499	783.1	238.70
1060	2503	782.6	238.55
1060	2498	783.9	238.95

F 166

1281	3481	621.3	189.35
1284	3483	620.4	189.10
1287	3486	619.4	188.80
1291	3488	618.4	188.50
1296	3488	618.4	188.50
1301	3489	617.9	188.35
1305	3491	618.0	188.35
1310	3492	618.0	188.35

F 167

1052	2491	783.7	238.85
1053	2495	784.6	239.15
1054	2499	783.1	238.70
1060	2503	782.6	238.55
1060	2498	783.9	238.95

F 168

1280	3471	636.5	194.00
1284	3472	634.0	193.25
1283	3475	632.2	192.70
1288	3473	630.7	192.25

F 169

1077	2528	786.4	239.70
1080	2530	784.4	239.10
1083	2532	783.0	238.65

F 170

1298	3477	637.2	194.20
1301	3480	637.0	194.15
1303	3478	637.2	194.20
1305	3482	633.8	193.20

F 171

1071	2527	769.8	234.65
1073	2531	770.1	234.75
1075	2535	769.1	234.40
1078	2538	768.3	234.20
1081	2541	767.5	233.95
1084	2545	766.2	233.55
1087	2548	765.6	233.35

F 172

1311	3489	629.7	191.95

F 173

1113	2559	818.8	249.55
1111	2563	807.2	246.05
1109	2567	798.2	243.30

F 174

1320	3497	626.9	191.10
1322	3500	628.8	191.65
1325	3503	603.1	192.05

F 175

1096	2568	764.8	233.10
1098	2572	763.8	232.80
1100	2576	761.9	232.25
1102	2580	762.2	232.30
1107	2579	762.1	232.30
1112	2578	762.3	232.35
1104	2585	761.6	232.15
1106	2589	760.8	231.90

F 176

1252	3364	632.9	192.90
1256	3366	632.7	192.85
1260	3367	631.9	192.60
1265	3368	630.6	192.20
1268	3371	629.7	191.95
1271	3374	628.9	191.70
1275	3377	628.3	191.50
1278	3380	627.9	191.40
1282	3383	627.5	191.25
1285	3386	627.8	191.35
1289	3389	627.8	191.35
1292	3392	627.7	191.30
1296	3396	627.3	191.20
1300	3398	626.5	190.95
1295	3399	626.3	190.90
1291	3400	626.1	190.85
1309	3413	626.1	190.85
1307	3418	625.7	190.70
1305	3422	625.0	190.50
1300	3426	625.1	190.55
1295	3429	624.3	190.30
1291	3432	623.4	190.00
1286	3434	622.5	189.75
1281	3435	622.0	189.60
1278	3431	621.2	189.35
1273	3433	620.9	189.25
1271	3438	620.4	189.10
1270	3444	620.2	189.05
1270	3449	619.9	188.95
1269	3454	619.9	188.95
1267	3459	619.5	188.80
1266	3463	619.1	188.70
1265	3468	619.8	188.90
1311	3417	626.5	190.95
1313	3421	625.4	190.60
1315	3425	624.7	190.40
1317	3429	624.5	190.35
1320	3433	624.4	190.30
1323	3436	624.2	190.25
1326	3440	623.7	190.10
1326	3444	623.0	189.90
1325	3448	622.4	189.70
1325	3453	621.6	189.45
1325	3458	621.1	189.30
1325	3462	621.1	189.30
1325	3467	621.1	189.30
1325	3472	621.5	189.45
1326	3476	620.8	189.20
1329	3480	619.9	188.95
1325	3483	619.8	188.90
1321	3485	619.3	188.75
1331	3485	620.0	190.00
1332	3489	619.8	188.90
1333	3494	619.3	188.75
1334	3499	618.7	188.60
1334	3504	618.8	188.60
1335	3508	618.1	188.40
1335	3513	617.3	188.15

F 177

1086	2577	761.7	232.15
1088	2581	760.1	231.70
1090	2585	759.8	231.60
1092	2589	758.5	231.20
1093	2593	756.4	230.55
1094	2597	755.8	230.35
1096	2601	755.4	230.25
1098	2606	754.3	229.90
1101	2609	753.5	229.65
1105	2612	752.3	229.30
1109	2614	751.9	229.20
1112	2615	751.5	229.05

F 178

1275	3444	627.3	191.20
1279	3446	624.7	190.40
1278	3439	628.7	191.65
1283	3439	627.1	191.15

F 179

1126	2608	792.5	241.55
1122	2608	791.0	241.10
1131	2607	795.2	242.40
1127	2612	789.6	240.65
1129	2617	787.2	239.95
1131	2622	784.1	239.00

F 181

1137	2657	742.6	226.35
1137	2662	741.2	225.90
1142	2661	740.3	225.65
1136	2667	738.6	225.15
1136	2672	738.6	225.15
1135	2676	738.3	225.05
1134	2680	736.6	224.50
1133	2684	736.2	224.40
1132	2688	734.8	223.95
1131	2693	734.2	223.80

F 182

1686	3577	587.7	179.15
1691	3577	587.8	179.15
1695	3578	587.4	179.05
1700	3579	587.7	179.15
1704	3579	587.3	179.00
1709	3579	586.6	178.80
1714	3580	586.2	178.65
1718	3582	585.8	178.55
1722	3585	585.2	178.35
1725	3588	584.7	178.20
1721	3591	584.9	178.30
1717	3594	584.6	178.20
1713	3597	584.4	178.15
1711	3599	584.6	178.20
1727	3592	584.2	178.05
1729	3596	584.2	178.05
1729	3601	584.7	178.20
1729	3605	584.8	178.25
1729	3610	584.6	178.20
1730	3615	584.4	178.15
1734	3618	584.2	178.05
1738	3621	584.3	178.10
1741	3624	583.8	177.95
1745	3627	583.4	177.80
1750	3630	582.3	177.50
1755	3633	582.0	177.40
1759	3636	581.6	177.25
1763	3639	581.3	177.20
1767	3643	579.9	176.75

F 183

1133	2718	740.9	225.85
1131	2723	739.5	225.40
1129	2727	738.6	225.15
1127	2731	737.9	224.90
1126	2735	737.2	224.70
1122	2735	735.8	224.25
1126	2740	736.1	224.35
1125	2745	735.4	224.15
1124	2750	732.5	223.25
1123	2755	731.2	222.85
1123	2760	728.9	222.15
1124	2765	727.4	221.70
1123	2770	725.3	221.05
1122	2775	726.3	221.40

F 184

1800	3697	587.4	179.05
1802	3701	587.7	179.15
1805	3706	586.7	178.85
1801	3708	584.4	178.15
1808	3709	587.5	179.05
1811	3713	586.6	178.80
1815	3723	585.0	178.30

F 185

1126	2717	731.2	222.85
1124	2721	730.7	222.70
1123	2726	728.9	222.15
1121	2730	728.2	221.95
1120	2734	728.0	221.90
1119	2738	726.9	221.55
1118	2743	726.6	221.45
1117	2748	725.7	221.20
1116	2752	724.7	220.90
1116	2757	724.0	220.70
1115	2761	723.8	220.60
1114	2765	723.3	220.45
1113	2770	722.1	220.10
1111	2774	722.9	220.35
1109	2778	722.3	220.15
1107	2782	720.0	219.45
1106	2786	718.9	219.10
1106	2791	717.9	218.80
1106	2795	717.3	218.65
1108	2800	715.8	218.20
1110	2804	714.0	217.65

F 186

1814	3698	578.6	176.35
1816	3702	577.7	176.10
1818	3707	577.5	176.00
1820	3711	577.3	175.95
1822	3716	577.4	176.00
1823	3721	576.9	175.85
1824	3726	576.6	175.75
1825	3730	576.0	175.55
1826	3735	575.6	175.45
1829	3739	575.0	175.25
1831	3742	575.4	175.40
1833	3746	575.4	175.40

1835	3750	575.3	175.35
1837	3754	575.0	175.25

F 187

1108	2827	736.2	224.40
1107	2831	736.2	224.40
1106	2835	735.0	224.05
1106	2840	734.1	223.75
1105	2844	733.5	223.55
1105	2848	732.6	223.30
1105	2852	731.7	223.00
1106	2857	730.2	222.55
1110	2857	729.8	222.45
1110	2861	730.1	222.55
1115	2862	728.1	221.90

F 188

1842	3756	575.5	175.40
1845	3757	573.4	174.75
1849	3759	573.9	174.90
1853	3761	573.8	174.90
1855	3765	574.3	175.05
1858	3768	574.1	175.00
1861	3771	572.7	174.55
1864	3774	573.3	174.75
1864	3779	572.6	174.55
1867	3781	572.6	174.55
1870	3783	572.3	174.45
1874	3785	571.9	174.30
1877	3788	571.7	174.25
1880	3791	572.1	174.40
1882	3794	571.0	174.05
1885	3797	571.0	174.05
1887	3800	570.6	173.90
1884	3802	570.0	173.75
1881	3805	570.5	173.90
1890	3803	570.2	173.80
1891	3806	570.1	173.75
1893	3809	570.3	173.85
1895	3812	569.7	173.65
1898	3816	569.8	173.65
1900	3820	568.9	173.40
1902	3824	568.8	173.35
1904	3825	570.1	173.75
1907	3827	569.5	173.60
1910	3830	569.4	173.55
1912	3833	569.8	173.70
1915	3836	570.1	173.75
1917	3839	569.4	173.55
1919	3842	569.1	173.45
1921	3846	569.4	173.55
1921	3850	568.9	173.40
1921	3854	568.5	173.30

1920	3858	568.6	173.30
1920	3862	567.9	173.10

F 189

1103	2823	714.0	217.65
1102	2828	713.6	217.50
1100	2832	713.0	217.30
1098	2836	712.5	217.15
1097	2841	711.6	216.90
1095	2845	710.0	216.40
1093	2852	709.3	216.20
1091	2860	707.7	215.70
1090	2865	706.8	215.45
1089	2871	705.3	215.00
1088	2875	705.2	214.95
1088	2880	705.5	215.05
1089	2885	704.4	214.70
1091	2890	703.1	214.30
1093	2894	701.9	213.95
1096	2898	701.2	213.75
1099	2901	701.2	213.75
1102	2905	700.3	213.45
1105	2908	698.9	213.00
1108	2912	698.8	213.00
1112	2909	697.7	212.65
1116	2906	698.1	212.80
1120	2903	699.4	213.20
1124	2900	697.8	212.70
1111	2915	698.1	212.80
1114	2919	697.2	212.50
1117	2923	696.9	212.40
1120	2926	696.4	212.25
1123	2930	695.3	211.95
1127	2932	694.1	211.55
1130	2936	692.7	211.15
1133	2940	691.3	210.70
1136	2944	691.5	210.75
1139	2948	690.6	210.50
1142	2953	689.9	210.30
1145	2957	688.5	209.85
1147	2961	687.6	209.60
1149	2965	687.7	209.60
1151	2968	686.4	209.20
1153	2972	686.0	209.10
1155	2975	685.3	208.90
1158	2980	684.3	208.55
1161	2985	684.1	208.50
1166	2983	683.7	208.40
1170	2981	681.8	207.80
1174	2978	684.1	208.50
1179	2977	684.1	208.50
1183	2975	681.7	207.80
1165	2988	683.1	208.20
1169	2991	682.6	208.05

1173	2994	682.4	208.00
1177	2997	681.5	207.70
1181	3000	681.0	207.55
1184	3003	680.0	207.25
1186	3006	680.2	207.30
1188	3009	679.3	207.05
1190	3012	678.0	206.65
1191	3016	677.8	206.60
1195	3015	680.2	207.30
1194	3020	678.0	206.65
1196	3024	676.6	206.25
1198	3028	675.2	205.80
1201	3033	675.5	205.90

<u>F 190</u>

1840	3778	586.2	178.65
1843	3782	586.2	178.65
1846	3785	585.6	178.50
1849	3788	587.1	178.95
1852	3792	586.8	178.85
1854	3795	585.6	178.50
1857	3798	584.6	178.20
1860	3801	584.8	178.25
1866	3798	584.7	178.20
1870	3800	585.1	178.35
1872	3804	585.8	178.55
1875	3807	584.6	178.20
1882	3811	584.7	178.20
1885	3814	583.7	177.90
1888	3817	585.0	178.30
1891	3820	585.4	178.45
1893	3819	585.2	178.35
1887	3823	581.2	177.15
1884	3826	581.4	177.20
1880	3829	581.8	177.35
1894	3824	585.4	178.45
1897	3828	585.4	178.45
1900	3832	586.1	178.65

<u>F 191</u>

1121	2880	727.2	221.65
1122	2885	724.3	220.75
1123	2890	722.5	220.20
1125	2894	719.7	219.35

<u>F 192</u>

1870	3832	624.7	190.40
1873	3835	623.9	190.15
1876	3838	622.1	189.60
1879	3842	622.8	189.85
1882	3845	621.9	189.55
1886	3844	622.2	189.65
1878	3846	621.7	189.50

<u>F 194</u>

1907	3850	580.8	177.05
1911	3853	579.8	176.70

<u>F 196</u>

1912	3865	595.0	181.35
1916	3868	597.3	182.05
1920	3871	594.1	181.10

<u>F 198</u>

1928	3879	590.6	180.00
1931	3883	590.2	179.90
1933	3888	589.8	179.75
1936	3892	588.9	179.50
1947	3899	587.1	178.95
1945	3904	587.9	179.20
1944	3913	586.4	178.75

<u>F 200</u>

1926	3870	568.0	173.15
1913	3871	567.8	173.05
1936	3873	567.8	173.05
1940	3875	567.1	172.85
1944	3877	566.8	172.75
1948	3880	566.3	172.60
1951	3885	565.9	172.50
1953	3890	566.0	172.50
1949	3891	564.2	172.00
1952	3895	565.5	172.35
1951	3899	564.3	172.00
1950	3903	564.1	171.95
1949	3908	565.0	172.20
1948	3913	565.1	172.25

<u>F 202</u>

1914	3882	631.3	192.40
1920	3888	632.0	192.65
1904	3903	635.4	193.65
1910	3908	635.1	193.60

<u>F 203</u>

1308	3397	628.2	191.50
1310	3401	624.9	190.45
1312	3405	625.3	190.60
1314	3408	624.5	190.35
1316	3412	624.3	190.30
1318	3416	623.7	190.10

1320	3419	622.9	189.85
1321	3423	622.3	189.70
1323	3426	622.5	189.75
1325	3429	621.8	189.50
1328	3432	621.9	189.55
1331	3435	621.5	189.45
1333	3439	624.3	190.30
1333	3443	622.8	189.85
1334	3448	621.5	189.45
1335	3455	621.4	189.40
1340	3455	621.8	189.50
1342	3451	625.6	190.70
1345	3448	628.8	191.65
1348	3445	632.3	192.75
1351	3442	635.7	193.75
1354	3439	638.9	194.70
1357	3435	642.8	195.95
1359	3432	648.5	197.65
1362	3429	651.6	198.60
1364	3425	656.4	200.05
1333	3460	622.0	189.60
1332	3464	621.7	189.50
1332	3468	621.1	189.30
1333	3473	620.8	189.20
1334	3477	620.8	189.20
1335	3481	620.6	189.15
1338	3484	620.0	189.00
1339	3488	616.8	188.00
1340	3492	618.9	188.65
1341	3496	619.4	188.80
1342	3500	618.6	188.55
1342	3504	619.0	188.65
1342	3508	618.5	188.50
1341	3512	617.4	188.20
1340	3516	617.9	188.35
1338	3519	617.2	188.10
1338	3523	616.6	187.95
1339	3527	616.6	187.95
1342	3530	615.3	187.55
1346	3531	614.8	187.40
1350	3533	614.5	187.30
1354	3535	613.2	186.90
1358	3537	612.9	186.80
1363	3537	612.3	186.65
1365	3540	612.7	186.75
1367	3543	612.5	186.70
1371	3545	612.5	186.70
1375	3547	612.6	186.70
1378	3549	612.5	186.70
1382	3550	612.3	186.65
1385	3552	612.1	186.55
1386	3548	610.7	186.15
1388	3545	612.7	186.75
1390	3542	617.0	188.05
1392	3538	613.6	187.05
1395	3535	610.1	185.95
1398	3532	610.1	185.95
1401	3529	609.6	185.80
1403	3526	608.9	185.60
1406	3523	608.7	185.55
1409	3520	608.1	185.35
1412	3517	608.9	185.60
1414	3513	609.3	185.70
1417	3510	609.0	185.60
1420	3506	609.4	185.75
1423	3503	609.0	185.60
1425	3499	609.1	185.65
1428	3496	608.7	185.55
1385	3554	612.4	186.65
1390	3555	612.6	186.70
1394	3557	611.4	186.35
1398	3558	610.8	186.15
1402	3559	610.3	186.00
1407	3559	610.1	185.95
1411	3560	610.1	185.95
1416	3560	609.4	185.75
1421	3561	609.7	185.85
1426	3562	608.4	185.45
1431	3563	608.7	185.55
1436	3563	608.5	185.45
1441	3563	608.2	185.40
1446	3563	607.4	185.15
1450	3562	607.4	185.15
1455	3562	607.3	185.10
1459	3562	607.2	185.05
1464	3562	606.7	184.90
1468	3563	605.3	184.50
1472	3565	604.3	184.20
1477	3567	605.2	184.45
1482	3568	604.5	184.25
1486	3569	604.1	184.15
1491	3570	603.4	183.90
1496	3570	603.2	183.85
1501	3570	602.4	183.60
1506	3570	602.3	183.60
1511	3569	602.5	183.65
1515	3566	602.5	183.65
1520	3564	602.3	183.60
1523	3560	601.1	183.20
1527	3558	601.5	183.35
1531	3557	601.0	183.20
1536	3558	600.1	182.90
1540	3560	598.7	182.50
1545	3559	598.9	182.55
1551	3558	598.3	182.35
1556	3557	596.9	181.95
1562	3556	595.3	181.45
1567	3555	596.1	181.70
1572	3553	595.8	181.60
1576	3550	595.9	181.65

1581	3546	595.8	181.60
1583	3542	596.9	181.95
1587	3538	597.1	182.00
1591	3535	596.8	181.90
1598	3533	596.8	181.90
1596	3530	595.4	181.50
1603	3532	596.7	181.85
1608	3531	595.8	181.60
1613	3529	594.8	181.30
1618	3527	594.3	181.15
1621	3525	593.9	181.00
1626	3524	594.6	181.25
1630	3526	594.3	181.15
1632	3530	594.3	181.15
1635	3534	593.8	181.00
1637	3538	593.4	180.85
1640	3542	593.4	180.85
1642	3545	592.8	180.70
1644	3549	591.9	180.40
1648	3553	592.6	180.60
1152	3556	592.1	180.45
1656	3558	591.9	180.40
1661	3559	590.4	179.95
1665	3561	589.6	179.70
1670	3563	589.7	179.75
1674	3565	589.6	179.70
1678	3567	589.0	179.55
1682	3568	588.8	179.45
1686	3569	588.8	179.45
1691	3569	588.2	179.30
1695	3570	588.1	179.25
1699	3571	587.5	179.05
1703	3571	588.0	179.20
1706	3568	587.5	179.05
1710	3565	587.3	179.00
1714	3562	587.1	178.95
1717	3559	587.9	179.20
1721	3556	587.6	179.10
1725	3553	588.7	179.45
1709	3572	587.7	179.15
1714	3573	587.7	179.15
1718	3575	587.4	179.05
1722	3577	586.5	178.75
1726	3580	586.0	178.60
1729	3583	586.1	178.65
1731	3586	586.0	178.60
1733	3590	587.8	179.15
1734	3595	588.4	179.35
1735	3600	588.5	179.35
1734	3604	588.3	179.30
1733	3609	587.6	179.10
1735	3613	585.8	178.55
1738	3610	585.9	178.60
1742	3608	585.5	178.45
1745	3606	585.6	178.50
1748	3603	584.9	178.30
1751	3601	585.3	178.40
1740	3613	585.7	178.50
1744	3614	586.6	178.80
1748	3617	586.3	178.70
1752	3620	586.0	178.60
1755	3625	585.2	178.35
1760	3631	585.4	178.45
1764	3634	584.6	178.20
1768	3637	584.3	178.10
1771	3640	584.1	178.05
1775	3638	582.3	177.50
1773	3645	583.5	177.85
1773	3649	583.7	177.90
1774	3652	583.6	177.90
1778	3652	582.2	177.45
1782	3653	580.8	177.05

F 204

1956	3938	563.9	171.90
1959	3942	563.8	171.85
1962	3946	563.7	171.80
1965	3950	563.0	171.60
1968	3954	563.3	171.70
1970	3958	562.8	171.55
1973	3961	562.5	171.45
1975	3965	562.1	171.35
1976	3970	562.0	171.30
1978	3975	559.1	170.40
1981	3979	560.9	170.95

F 205

1328	3403	670.4	204.35
1328	3407	667.2	203.35
1326	3418	665.6	202.85
1329	3422	665.8	202.95
1333	3423	665.1	202.70
1337	3423	666.1	203.05
1341	3422	669.8	204.15
1345	3422	671.6	204.70
1349	3421	675.9	206.00
1352	3419	679.8	207.20
1355	3417	682.0	207.85

F 206

1970	3993	644.7	196.50
1972	3996	643.3	196.10
1971	3996	643.6	196.15
1973	3996	642.7	195.90
1974	4000	640.3	195.15

F 207

1368	3400	701.6	213.85
1368	3404	698.7	212.95
1368	3408	696.6	212.30
1369	3413	694.5	211.70
1370	3417	693.4	211.35
1378	3435	685.1	208.80
1380	3439	682.2	207.95
1383	3442	679.2	207.00
1386	3445	677.6	206.55
1389	3447	674.5	205.60
1391	3450	672.7	205.05
1394	3453	670.9	204.50
1397	3456	666.7	203.20
1400	3459	662.6	201.95
1403	3463	660.5	201.30
1407	3466	658.9	200.85
1410	3470	656.7	200.15
1412	3473	653.3	199.15
1415	3476	650.0	198.10

F 208

1957	3994	629.6	191.90
1960	3998	628.4	191.55
1964	4001	627.5	191.25
1967	4004	626.7	191.00
1970	4007	626.0	190.80
1973	4010	623.2	189.95
1976	4011	621.3	189.35
1978	4013	620.3	189.05
1980	4016	619.4	188.80
1972	3983	624.0	190.20
1973	3986	622.9	189.85
1975	3989	621.9	189.55
1977	3992	621.2	189.35
1979	3996	620.2	189.05
1981	3999	619.0	188.65
1983	4003	617.6	188.25
1985	4007	616.5	187.90
1987	4010	615.7	187.65
1988	4013	614.6	187.35
1987	4014	615.6	187.65
1984	4015	617.9	188.35
1982	4017	617.0	188.05
1985	4020	615.2	187.50
1986	4023	614.4	187.25
1988	4026	612.7	186.75
1990	4029	610.9	186.20
1992	4033	608.9	185.60
1995	4032	607.3	185.10
1999	4030	608.5	185.45
1988	4035	610.2	186.00
1985	4036	611.5	186.40
1994	4036	607.2	185.05
1995	4039	606.5	184.85

F 209

1526	3513	680.7	207.50
1531	3513	679.5	207.10
1534	3516	678.5	206.80
1539	3516	672.8	205.05

F 210

1968	4013	629.7	191.95
1971	4015	629.5	191.85
1974	4018	627.4	191.25
1976	4022	631.6	192.50
1979	4026	630.5	192.20
1982	4030	628.1	191.45

F 211

1790	3651	631.1	192.35
1792	3655	627.4	191.25
1796	3657	626.6	191.00
1800	3660	624.9	190.45
1803	3657	626.7	191.00

F 212

1945	4002	708.62	216.00
1946	4005	706.72	215.40
1948	4009	703.93	214.55
1951	4013	701.21	213.75
1947	4016	700.35	213.50
1955	4011	700.35	213.50
1954	4017	698.23	212.80
1956	4020	695.61	212.00

F 213

1811	3682	578.6	176.35
1814	3685	578.2	176.25
1816	3689	578.3	176.25
1819	3693	577.9	176.15
1822	3697	576.6	175.75
1824	3702	578.1	176.20
1825	3707	577.9	176.15
1826	3711	577.6	176.05
1827	3715	577.0	175.85
1828	3720	576.3	175.65
1830	3724	576.6	175.75
1831	3728	576.3	175.65
1833	3732	576.1	175.60
1837	3740	575.9	175.55
1838	3744	576.3	175.65
1840	3747	576.2	175.65
1843	3750	576.2	175.65
1846	3752	575.9	175.55

1850	3754	575.5	175.40
1853	3756	575.0	175.25
1856	3759	574.5	175.10
1860	3762	574.6	175.15
1862	3765	574.5	175.10
1864	3768	573.7	174.85
1866	3771	573.3	174.75
1869	3773	573.3	174.75
1872	3775	572.7	174.55
1875	3777	572.5	174.50
1878	3779	572.2	174.40
1881	3782	571.3	174.15
1884	3784	570.9	174.00
1887	3786	571.0	174.05

F 214

1969	4026	643.3	196.10
1967	4027	643.0	196.00
1970	4030	641.9	195.65
1973	4034	639.5	194.90
1976	4038	639.5	194.90
1979	4042	638.3	194.55

F 215

1837	3725	592.4	180.55
1839	3728	593.1	180.80
1842	3732	593.2	180.80
1845	3736	593.6	180.90
1847	3743	596.9	181.95

F 216

1988	3991	645.6	196.80
1991	3994	643.9	196.25
1994	3998	641.4	195.50
1996	4003	638.6	194.65
1998	4008	638.3	194.55
1999	4012	635.4	193.65
1999	4017	633.6	193.10
2001	4022	630.2	192.10
2003	4026	626.7	191.00
2005	4029	625.0	190.50
2008	4033	623.3	190.00
2012	4032	623.8	190.15
2016	4030	624.2	190.25
2020	4027	627.4	191.25
2025	4021	625.4	190.60
2028	4017	623.2	189.95
2032	4014	623.2	189.95
2036	4012	621.7	189.50
2040	4010	621.8	189.50
2044	4008	620.8	189.20

1992	3993	643.7	196.20
1997	3995	641.7	195.60
2001	3996	638.9	194.75
2006	3998	636.6	194.05
2010	3999	634.8	193.50
2015	4000	632.6	192.80
2020	4000	631.4	192.45
2024	4000	628.7	191.65
2028	4000	627.2	191.15
2033	4000	625.1	190.55
2037	4000	622.0	189.60

F 217

1907	3788	602.3	183.60
1910	3795	601.0	183.20
1913	3798	599.2	182.65

F 218

1864	4073	593.1	180.80
1862	4069	592.4	180.55
1860	4065	592.4	180.55
1857	4062	591.6	180.30
1856	4058	591.0	180.15
1855	4053	589.9	179.80
1855	4048	590.4	179.95
1857	4044	589.2	179.60
1859	4040	588.7	179.45
1861	4035	588.8	179.45
1864	4038	588.7	179.45
1866	4040	588.6	179.40
1865	4031	588.1	179.25
1870	4029	587.3	179.00
1874	4029	587.1	178.95
1879	4026	586.5	178.75
1884	4024	586.4	178.75
1889	4023	586.4	178.75
1894	4023	586.0	178.60
1899	4023	585.9	178.60
1904	4025	585.5	178.45
1906	4029	585.4	178.45
1908	4027	584.9	178.30
1910	4029	584.2	178.05
1914	4031	583.3	177.80

F 219

1912	3805	610.3	186.00
1913	3812	608.0	185.30

F 220

1922	4028	583.6	177.90
1926	4027	582.8	177.65
1930	4026	581.7	177.30
1934	4027	581.2	177.15

1939	4027	581.0	177.10
1944	4028	581.0	177.10
1942	4031	580.7	177.00
1949	4031	579.5	176.65
1952	4034	578.4	176.30
1956	4036	578.8	176.40
1961	4039	577.3	175.95
1966	4041	576.8	175.80
1970	4044	576.1	175.60
1974	4047	575.7	175.45
1975	4052	574.9	175.25
1976	4056	574.1	175.00
1978	4060	574.6	175.15

F 221

1890	3790	572.5	174.50
1892	3792	572.2	174.40
1894	3796	571.2	174.10
1896	3800	572.0	174.35
1898	3803	570.8	174.00
1900	3807	570.5	173.90
1902	3810	570.8	174.00
1904	3814	571.1	174.05
1905	3818	571.0	174.05
1906	3821	570.6	173.90
1908	3824	570.0	173.75
1911	3822	568.8	173.35
1913	3820	568.7	173.35
1911	3827	569.8	173.70
1913	3830	569.4	173.55
1916	3832	569.1	173.45
1918	3835	569.1	173.45
1920	3838	568.6	173.30
1922	3841	568.8	173.35
1924	3844	568.2	173.20
1925	3847	567.5	172.95
1926	3850	568.0	173.15
1925	3854	568.1	173.15
1925	3858	568.1	173.15
1925	3862	567.8	173.05
1926	3865	568.0	173.15
1929	3868	567.5	172.95
1931	3865	564.8	172.15
1933	3870	566.4	172.65
1936	3871	566.7	172.75
1939	3873	566.7	172.75
1942	3874	566.3	172.60
1945	3875	565.8	172.45

F 222

1875	4105	700.8	213.60
1875	4101	701.2	213.75
1875	4097	695.7	212.05
1875	4092	692.0	210.90
1875	4087	690.3	210.40
1873	4084	693.6	211.40
1872	4080	689.1	210.05
1876	4080	686.1	209.10
1881	4081	681.1	207.60
1885	4081	676.0	206.05
1873	4076	692.8	211.15
1873	4071	693.9	211.50
1873	4066	694.9	211.80
1876	4062	693.2	211.30
1879	4059	688.6	209.90
1882	4055	686.5	209.25
1885	4052	682.0	207.85
1888	4049	678.1	206.70
1884	4046	678.9	206.95
1880	4043	677.4	206.45
1892	4052	677.8	206.60
1891	4046	674.4	205.55
1894	4043	671.0	204.50
1898	4041	668.1	203.65
1902	4038	669.1	203.90

F 223

1938	3852	575.8	175.50
1940	3857	575.5	175.40
1942	3861	574.6	175.15
1944	3865	573.0	174.65
1946	3869	571.4	174.15
1949	3872	569.6	173.60
1951	3876	568.3	173.20

F 224

1844	4077	704.2	214.65
1844	4073	703.2	214.35
1847	4073	687.6	212.65
1843	4072	701.5	213.80
1840	4071	702.7	214.20
1836	4070	701.3	213.75
1844	4069	701.5	213.80

F 225

1955	3896	564.0	171.90
1955	3900	563.5	171.75
1954	3905	563.6	171.80
1953	3909	563.5	171.75
1952	3912	563.0	171.60
1952	3915	563.5	171.75
1953	3920	563.0	171.60
1956	3919	562.4	171.40
1954	3924	562.5	171.45
1955	3928	562.4	171.40
1957	3932	562.5	171.45
1959	3936	562.7	171.50

1962	3939	561.1	171.00
1965	3943	560.8	170.95
1968	3946	560.2	170.75
1970	3950	560.4	170.80
1972	3954	559.9	170.65
1974	3958	559.8	170.65
1976	3962	559.7	170.60
1978	3965	559.6	170.55
1980	3969	559.2	170.45
1982	3973	558.2	170.15
1985	3977	558.2	170.15
1989	3979	557.6	169.95
1993	3981	558.8	170.30
1997	3983	559.4	170.50
2002	3984	558.1	170.10
2007	3985	558.1	170.10
2012	3985	558.2	170.15
2017	3985	557.7	170.00
2022	3985	557.7	170.00

F 226

1914	4039	607.8	185.25
1917	4040	611.1	186.25
1921	4042	609.6	185.80
1925	4043	608.8	185.55
1929	4044	608.5	185.45
1933	4046	609.2	185.70
1937	4047	608.4	185.45
1935	4050	607.8	185.25
1938	4051	607.5	185.15
1943	4053	606.9	185.00

F 227

1985	3933	624.6	190.40
1989	3937	621.3	189.35
1993	3940	622.6	189.75
1997	3943	620.3	189.05
2001	3946	618.7	188.60

F 228

1941	4041	594.0	181.05
1945	4043	593.3	180.85
1950	4045	593.3	180.85
1955	4047	593.1	180.80
1954	4051	593.5	180.90

F 229

1987	3939	605.2	184.45
1992	3942	605.9	184.70

F 231

1985	3956	590.8	180.10
1989	3960	589.3	179.60
1993	3962	588.3	179.30
1998	3962	587.3	179.00

F 232

1985	4058	572.4	174.45
1986	4054	571.5	174.20
1989	4050	570.8	174.00
1992	4049	569.7	173.65
1996	4047	569.8	173.70
2001	4045	569.9	173.70
2002	4048	570.5	173.90
2006	4044	570.4	173.85
2010	4045	569.6	173.60
2013	4047	569.3	173.50

F 233

1986	3965	574.1	175.00
1990	3968	574.0	174.95

F 234

2015	4044	568.2	173.20
2018	4044	567.8	173.05
2022	4043	567.6	173.00
2025	4042	567.3	172.90
2028	4040	566.4	172.65
2031	4038	566.1	172.55
2034	4036	566.1	172.55
2036	4034	565.6	172.40

F 236

2015	4043	570.5	173.90
2018	4042	570.4	173.85
2023	4040	570.2	173.80
2026	4038	569.8	173.70
2030	4037	569.5	173.60
2028	4035	568.7	173.35
2027	4034	568.0	173.15
2033	4034	568.8	173.35
2035	4032	568.4	173.25
2038	4029	567.7	173.05
2041	4027	567.0	172.80

F 237

2105	3967	599.8	182.80

2109	3964	598.7	182.50
2112	3960	596.3	181.75
2115	3957	595.0	181.35
2118	3954	593.9	181.00
2122	3950	592.3	180.55
2125	3952	591.6	180.30
2129	3954	594.0	181.05
2133	3955	595.6	181.55
2136	3956	593.7	180.95
2140	3957	595.8	181.60
2136	3952	594.5	181.20
2140	3948	593.0	180.75
2143	3945	592.9	180.70
2145	3941	593.2	180.80

F 238

2028	4030	582.1	177.40
2031	4028	582.2	177.45
2033	4025	582.3	177.50
2036	4023	582.1	177.40
2039	4020	582.0	177.40
2043	4018	582.1	177.40
2046	4016	582.3	177.50
2050	4013	582.1	177.40
2053	4011	582.2	177.45
2057	4009	582.7	177.60
2060	4007	583.2	177.75
2071	4006	582.5	177.55
2068	4005	581.7	177.30
2064	4004	581.1	177.10
2061	4003	582.4	177.50
2070	4001	582.2	177.45
2068	3997	582.3	177.50
2066	3993	579.4	176.60

F 239

2145	3977	550.7	167.85
2149	3975	550.0	167.65
2152	3972	551.3	168.05
2154	3968	551.5	168.10
2156	3964	551.7	168.15
2158	3962	549.9	167.60
2159	3959	550.8	167.90
2160	3955	549.8	167.60
2159	3951	548.3	167.10

F 240

2035	4046	597.8	182.20
2038	4043	597.2	182.05
2042	4040	596.4	181.80
2047	4038	595.5	181.50
2050	4035	595.4	181.50
2051	4038	597.0	182.00
2054	4034	594.2	181.10
2058	4033	592.9	180.70
2062	4031	592.7	180.65
2066	4029	593.2	180.80
2070	4027	592.5	180.60

F 241

2161	3924	581.1	177.10
2160	3920	580.7	177.00
2157	3917	580.5	176.95
2154	3915	581.1	177.10
2163	3923	581.4	177.20

F 243

2175	3917	554.9	169.15
2177	3913	554.5	169.00
2179	3909	555.0	169.15
2182	3905	555.1	169.20
2184	3902	555.8	169.40
2185	3898	556.4	169.60
2182	3895	552.9	168.50
2187	3895	556.4	169.60
2189	3890	554.8	169.10

F 244

2037	4035	568.1	173.15
2040	4033	567.7	173.05
2044	4030	566.7	172.75
2047	4027	566.0	172.50
2050	4023	565.9	172.50
2053	4020	565.8	172.45
2056	4018	565.0	172.20
2061	4018	565.2	172.25
2063	4020	565.5	172.35
2064	4022	565.5	172.35
2065	4016	565.5	172.35
2068	4014	563.9	171.90
2072	4014	562.9	171.55
2075	4014	561.6	171.20
2075	4018	562.3	171.40
2076	4022	563.4	171.70
2077	4027	565.0	172.20
2074	4013	561.4	171.10
2078	4014	561.5	171.15
2082	4016	560.5	170.85
2085	4017	559.5	170.55
2088	4017	559.7	170.60
2091	4017	558.9	170.35

F 245

2184	3910	553.9	168.85
2186	3906	554.3	168.95

2188	3902	553.8	168.80
2189	3898	550.6	167.80

F 246

2082	4028	591.0	180.15
2084	4028	591.8	180.40
2085	4026	591.8	180.40
2090	4023	591.7	180.35
2094	4020	590.7	180.05

F 247

2200	3908	550.1	167.65
2200	3903	549.2	167.40
2201	3899	548.4	167.15
2202	3895	548.3	167.10
2203	3890	547.9	167.00
2204	3885	547.4	166.85
2205	3884	547.5	166.90
2210	3885	547.4	166.85
2201	3883	548.1	167.05
2208	3880	547.1	166.75
2210	3875	546.4	166.55
2214	3871	545.6	166.30
2217	3868	545.5	166.25
2219	3867	545.3	166.20
2229	3864	543.8	165.75
2232	3864	545.6	166.30
2237	3866	544.5	165.95
2241	3868	544.1	165.85
2245	3871	543.2	165.55
2249	3874	542.9	165.50
2252	3878	543.1	165.55
2255	3881	542.6	165.40
2258	3885	543.0	165.50
2261	3888	542.1	165.25

F 248

2048	3993	595.4	181.50
2045	3993	596.7	181.85
2049	3996	594.6	181.25

F 249

2211	3905	571.1	174.05
2212	3905	571.5	174.20
2212	3902	568.8	173.35
2214	3899	568.4	173.25
2216	3895	569.8	173.70
2216	3893	569.7	173.65
2216	3890	567.4	172.95
2219	3896	569.4	173.55
2223	3893	569.5	173.60
2224	3894	566.2	172.60
2229	3887	565.1	172.25
2233	3888	563.0	171.60
2238	3890	558.0	170.10
2243	3891	559.0	170.40
2247	3894	559.8	170.65

F 250

2046	4008	611.5	186.40
2048	4006	614.6	187.35
2051	4004	615.0	187.45
2053	4002	612.5	186.70
2043	4000	618.1	188.40
2047	4000	617.5	188.20
2050	4001	615.1	187.50

F 251

2220	3907	546.6	166.60
2224	3906	547.3	166.80
2229	3905	547.2	166.80
2233	3904	546.5	166.55
2233	3900	545.4	166.25
2237	3903	546.0	166.40
2242	3901	545.0	166.10
2248	3900	544.1	165.85

F 252

2056	3987	578.7	176.40
2060	3987	578.8	176.40
2065	3987	578.5	176.35
2069	3987	574.3	175.05
2073	3987	572.8	174.60
2077	3987	570.9	174.00
2081	3988	570.0	173.75
2080	3986	568.9	173.40
2084	3989	569.3	173.50
2088	3989	570.1	173.75
2091	3990	569.9	173.70

F 253

2227	3876	554.9	169.15
2233	3878	554.8	169.10
2239	3880	554.5	169.00
2243	3882	553.0	168.55
2247	3885	554.6	169.05
2251	3888	554.8	169.10
2253	3892	554.7	169.05
2257	3895	554.2	168.90
2260	3898	553.1	168.60
2264	3902	552.3	168.35

2266	3907	550.4	167.75
2249	3882	546.6	166.60
2252	3885	546.9	166.70
2256	3888	545.6	166.30
2259	3891	544.8	166.05

F 255

2262	3890	541.6	165.10
2264	3892	541.0	164.90
2267	3896	540.8	164.85
2270	3900	540.6	164.75
2274	3903	540.0	164.60
2277	3908	539.8	164.55
2275	3916	543.4	165.65
2276	3920	542.2	165.25
2278	3924	541.6	165.10
2280	3928	542.1	165.25
2282	3931	542.2	165.25
2272	3933	540.8	164.85
2275	3934	542.3	165.30
2287	3930	540.1	164.60
2290	3930	540.9	164.85
2285	3935	542.1	165.25
2289	3939	539.6	164.45
2292	3943	540.1	164.60

F 256

2038	3988	557.4	169.90
2041	3986	558.0,	170.10
2045	3983	558.0	170.10
2049	3981	557.9	170.05
2053	3979	557.3	169.85
2058	3978	555.5	169.30
2063	3978	555.8	169.40
2067	3978	557.2	169.85
2072	3977	556.1	169.50
2074	3978	555.7	169.40
2076	3981	554.8	169.10
2078	3978	555.3	169.25
2083	3979	555.1	169.20
2087	3979	554.4	169.00
2092	3980	553.6	168.75
2097	3980	553.5	168.70
2102	3979	553.7	168.75
2108	3978	552.7	168.45
2100	3992	556.6	169.65
2102	3989	556.2	169.55
2104	3986	557.4	169.90
2106	3982	555.9	169.45

F 257

2301	3948	542.7	165.40
2297	3950	540.9	164.85
2296	3951	540.8	164.85
2299	3955	540.9	164.85
2300	3960	541.1	164.95
2303	3959	539.5	164.45
2301	3965	539.0	164.30
2302	3969	538.7	164.20
2303	3973	538.0	164.00
2305	3976	537.6	163.85

F 258

2078	4012	562.4	171.40
2083	4013	561.3	171.10
2086	4014	559.4	170.50
2089	4015	558.9	170.35
2093	4012	559.0	170.40
2092	4010	559.0	170.40

F 259

2336	4042	534.5	162.90
2337	4045	534.1	162.80
2338	4048	533.2	162.50
2340	4050	533.7	162.65
2343	4050	533.2	162.50
2347	4049	533.4	162.60
2350	4047	532.2	162.20
2352	4044	531.3	161.95

F 260

2097	4010	569.7	173.65
2101	4008	568.1	173.15
2104	4006	565.7	172.45

F 262

2102	4000	557.0	169.75
2104	3997	556.4	169.60
2107	3992	555.5	169.30
2110	3987	555.3	169.25
2113	3983	555.0	169.15
2115	3978	553.6	168.75
2120	3977	553.5	168.70
2125	3978	554.6	169.05
2125	3983	552.8	168.50
2125	3988	554.1	168.90
2126	3993	553.7	168.75
2126	3998	553.1	168.60

2130	3980	553.1	168.60
2135	3982	552.7	168.45
2140	3983	552.3	168.35
2146	3983	551.9	168.20

F 263

2431	4037	528.1	160.95
2437	4037	527.7	160.85
2442	4037	527.4	160.75
2447	4036	527.1	160.65
2452	4037	526.0	160.30
2456	4036	525.8	160.25
2461	4036	524.7	159.95
2466	4036	524.7	159.95

F 264

2161	3968	552.2	168.30
2163	3964	551.6	168.15
2165	3959	551.1	168.00
2166	3954	550.4	167.75
2166	3948	549.3	167.45
2167	3943	549.4	167.45
2168	3938	549.5	167.50
2170	3933	549.0	167.35
2173	3928	548.7	167.25
2177	3925	548.5	167.20
2181	3922	548.1	167.05
2184	3925	547.1	166.75
2187	3928	546.8	166.65
2186	3920	547.2	166.80
2191	3918	547.2	166.80
2196	3917	546.8	166.65
2201	3916	546.2	166.50
2206	3915	545.6	166.30
2211	3915	544.6	166.00
2216	3915	544.9	166.10
2217	3915	544.0	165.80
2220	3915	544.6	166.00
2224	3915	543.9	165.80
2228	3914	543.2	165.55
2232	3913	542.6	165.40
2235	3912	543.4	165.65
2239	3911	543.9	165.80
2242	3909	543.0	165.50
2246	3908	541.7	165.10
2250	3907	541.2	164.95
2254	3907	542.5	165.35
2257	3909	541.8	165.15
2260	3911	541.2	164.95
2262	3915	541.5	165.05
2263	3918	540.9	164.85
2264	3921	541.0	164.90

2265	3925	539.7	164.50
2266	3928	539.5	164.45
2267	3932	539.3	164.40
2268	3935	539.1	164.30

F 265

2503	4026	520.5	158.65
2508	4025	520.2	158.55
2513	4024	519.3	158.30
2518	4022	519.4	158.30
2523	4021	519.4	158.30
2528	4020	518.8	158.15
2532	4018	518.4	158.00

F 267

2533	3985	546.9	166.70
2537	3984	546.8	166.65
2540	3982	546.8	166.65
2538	3979	547.1	166.75

F 268

2226	3934	578.0	176.15
2230	3934	578.4	176.30
2230	3943	579.1	176.50
2234	3942	578.1	176.20
2238	3942	573.9	174.90
2243	3941	570.1	173.75
2247	3941	567.9	173.10
2257	3938	566.4	172.65
2262	3938	565.9	172.50
2266	3940	566.2	172.60
2270	3943	563.0	171.60
2275	3950	562.2	171.35
2279	3953	561.3	171.10
2282	3956	561.3	171.10
2286	3959	559.0	170.40

F 269

2522	4007	531.8	162.10
2526	4006	533.5	162.60
2530	4006	536.0	163.35
2535	4005	536.0	163.35
2531	4002	531.9	162.10
2539	4003	534.0	162.75
2542	4000	532.4	162.30
2535	3998	530.2	161.60
2539	3995	531.1	161.90
2542	3991	530.6	161.75
2546	3995	530.8	161.80
2550	3992	532.6	162.35

2554	3989	532.5	162.30

F 270

2292	3951	540.8	164.85
2294	3956	539.8	164.55
2295	3961	539.4	164.40
2297	3966	538.2	164.05
2299	3971	537.4	163.80
2306	3983	536.5	163.55
2309	3987	535.8	163.30
2312	3991	535.3	163.15
2314	3996	536.1	163.40
2315	4001	536.6	163.55
2317	4006	536.2	163.45
2320	4011	535.9	163.35
2323	4016	536.2	163.45
2326	4020	535.7	163.30
2327	4024	533.9	162.75
2328	4029	533.8	162.70
2329	4034	532.9	162.45
2330	4038	532.6	162.35
2331	4042	532.0	162.15
2331	4047	530.1	161.55

F 271

2550	4011	527.5	160.80
2554	4008	527.0	160.65
2558	4005	526.3	160.40
2562	4002	525.6	160.20
2566	3999	526.2	160.40
2570	3996	526.4	160.45
2575	3994	526.1	160.35
2579	3991	525.4	160.15
2585	3986	523.4	159.55
2589	3983	523.0	159.40
2593	3980	521.1	158.85
2598	3979	522.9	159.40
2602	3976	523.3	159.50
2606	3973	523.1	159.45
2612	3970	521.8	159.05
2616	3969	522.2	159.15
2620	3968	519.3	158.30
2625	3968	518.9	158.15
2630	3968	520.6	158.70
2634	3967	520.9	158.75
2639	3966	520.7	158.70
2644	3965	519.2	158.25
2648	3964	518.3	158.00
2652	3963	517.9	157.85
2656	3962	518.7	158.10
2656	3958	515.4	157.10
2655	3954	517.7	157.80
2655	3949	518.2	157.95
2654	3944	518.1	157.90
2654	3938	518.9	158.15
2653	3934	519.6	158.35
2653	3930	520.1	158.55
2652	3926	522.0	159.10
2652	3921	523.7	159.60
2660	3961	515.5	157.10
2665	3960	514.9	156.95
2669	3958	515.5	157.10
2673	3956	515.6	157.15
2677	3952	515.6	157.15
2681	3949	515.6	157.15
2685	3946	514.6	156.85
2688	3942	512.4	156.20
2691	3938	514.5	156.80
2695	3935	512.7	156.25
2700	3930	514.0	156.65
2702	3927	512.9	156.35
2704	3924	510.8	155.70
2706	3920	509.6	155.35
2710	3917	508.0	154.85
2712	3915	508.3	154.95
2717	3919	504.7	153.85
2720	3922	504.7	153.85
2723	3926	503.4	153.45

F 272

2361	4043	531.3	161.95
2365	4040	530.1	161.55
2370	4040	530.0	161.55
2369	4044	531.3	161.95
2373	4042	529.4	161.35
2377	4046	529.5	161.40
2381	4048	530.2	161.60
2384	4050	529.3	161.35

F 274

2402	4041	530.4	161.65
2405	4038	530.2	161.60
2410	4037	529.7	161.45
2414	4038	529.6	161.40
2419	4039	529.1	161.25
2423	4040	528.9	161.20
2428	4041	528.1	160.95
2433	4041	529.3	161.35
2437	4041	527.9	160.90
2442	4041	527.6	160.80
2447	4041	527.3	160.70
2452	4041	526.8	160.55
2456	4040	526.2	160.40
2461	4040	525.4	160.15

F 276

2425	4044	535.0	163.05
2429	4044	535.1	163.10

F 277

2666	3987	510.3	155.55
2671	3987	509.5	155.30
2675	3986	509.4	155.25
2680	3985	509.3	155.25
2684	3984	508.5	155.00
2688	3983	508.3	154.95
2692	3981	507.4	154.65
2696	3979	507.2	154.60
2699	3976	506.8	154.45
2702	3972	506.2	154.30
2704	3969	506.5	154.40
2706	3966	506.0	154.25
2704	3962	506.0	154.25
2701	3959	506.6	154.40
2698	3956	507.0	154.50
2707	3962	505.6	154.10
2709	3958	504.1	153.65
2710	3954	505.1	153.95
2711	3950	506.0	154.25
2713	3946	506.1	154.25
2716	3942	505.4	154.05
2719	3938	504.6	153.80
2721	3935	504.5	153.75
2724	3932	503.6	153.50
2727	3929	503.4	153.45
2730	3926	503.2	153.40

F 278

2440	4048	549.3	167.45
2444	4048	550.7	167.85
2448	4047	550.5	167.80
2452	4046	550.6	167.80
2456	4046	550.0	167.65
2460	4045	550.7	167.85

F 279

2685	3963	510.7	155.65
2689	3961	510.8	155.70
2693	3958	510.4	155.55
2690	3955	509.4	155.25
2695	3954	508.8	155.10
2698	3950	507.3	154.65

F 280

2447	4057	557.8	170.00
2452	4056	557.9	170.05
2456	4055	558.3	170.15
2460	4054	558.0	170.10
2463	4052	557.7	170.00
2465	4050	557.6	169.95
2468	4049	556.0	169.45
2472	4049	554.5	169.00
2476	4048	552.8	168.50
2480	4048	551.3	168.05
2484	4048	550.5	167.80
2487	4049	549.9	167.60
2486	4054	552.1	168.30
2485	4056	553.4	168.70
2484	4060	554.9	169.15
2483	4064	554.3	168.95
2482	4068	554.1	168.90
2481	4072	554.0	168.85
2480	4076	553.8	168.80
2484	4075	552.4	168.35
2488	4075	551.4	168.05
2492	4077	550.3	167.75
2496	4078	548.9	167.30
2476	4074	554.2	168.90
2472	4073	555.0	169.15
2468	4072	556.0	169.45
2465	4070	556.8	169.70
2480	4080	553.1	168.60
2480	4084	552.9	168.50
2479	4087	553.0	168.55

F 281

2782	3894	523.4	159.55
2780	3894	523.2	159.45
2784	3891	525.8	160.25

F 282

2508	4039	545.7	166.35
2513	4040	547.6	166.90
2517	4042	547.1	166.75
2522	4043	546.6	166.60
2526	4045	547.1	166.75
2527	4046	547.2	166.80
2527	4050	544.4	165.95
2527	4055	542.9	165.50
2527	4059	542.1	165.25
2527	4064	542.5	165.35
2532	4047	548.4	167.15
2537	4047	548.0	167.05
2537	4051	546.8	166.65
2538	4056	544.6	166.00
2538	4061	543.5	165.65
2541	4046	549.2	167.40
2546	4044	548.7	167.25

2550	4042	547.4	166.85
2563	4039	546.6	166.60
2568	4038	544.7	166.00
2573	4041	545.0	166.10
2578	4040	544.6	166.00
2582	4039	547.9	167.00
2583	4043	548.0	167.05
2587	4038	550.8	167.90
2592	4037	552.8	168.50
2596	4036	554.0	168.85
2600	4035	551.7	168.15

F 283

2784	3895	523.8	159.65
2786	3892	523.9	159.70
2788	3889	523.8	159.65
2790	3886	524.0	159.70
2792	3882	523.5	159.55
2793	3878	524.8	159.95

F 284

2505	4032	521.7	159.00
2510	4031	520.8	158.75
2515	4030	520.7	158.70
2520	4030	520.6	158.70
2525	4028	520.2	158.55
2530	4026	520.2	158.55
2531	4030	519.1	158.20
2532	4034	519.0	158.20
2535	4023	518.5	158.05
2539	4020	516.4	157.40
2544	4018	516.7	157.50
2549	4017	516.9	157.55
2555	4016	516.7	157.50
2560	4015	516.0	157.30
2565	4014	515.8	157.20
2569	4013	516.3	157.35
2568	4018	514.4	156.80
2566	4022	515.5	157.10
2564	4025	517.5	157.75
2572	4011	517.2	157.65
2576	4009	516.3	157.35
2580	4007	515.9	157.25
2585	4005	515.6	157.15
2590	4003	514.6	156.85
2595	4002	514.3	156.75
2595	4007	513.7	156.60
2595	4012	513.8	156.60
2595	4017	515.3	157.05
2595	4022	518.3	158.00
2599	4000	513.8	156.60
2605	3999	513.6	156.55
2610	3997	511.6	155.95
2615	3996	512.5	156.20
2620	3996	512.3	156.15
2625	3995	511.5	155.90
2630	3994	512.7	156.25
2632	3999	511.7	155.95
2634	4003	512.5	156.20
2635	4008	511.5	155.90
2637	4013	511.4	155.85
2634	3992	513.0	156.35
2638	3989	512.1	156.10
2642	3986	511.9	156.05
2647	3986	511.5	155.90
2652	3987	511.2	155.80
2657	3989	511.3	155.85
2660	3991	510.2	155.50
2664	3995	509.8	155.40
2667	3998	508.7	155.05
2670	4002	508.6	155.00

F 285

2767	3915	499.5	152.25
2771	3914	501.0	152.70
2775	3913	500.9	152.65
2778	3910	500.7	152.60
2782	3908	500.3	152.50
2785	3906	499.4	152.20
2789	3904	499.4	152.20
2791	3899	499.3	152.20
2793	3895	499.4	152.20
2795	3897	498.6	151.95
2793	3892	499.8	152.35
2797	3893	499.4	152.20
2801	3891	498.8	152.05
2804	3889	499.1	152.15
2808	3888	498.9	152.05
2813	3888	498.6	151.95
2812	3884	499.2	152.15
2811	3880	498.8	152.05
2817	3888	497.9	151.75
2821	3887	497.1	151.50
2826	3887	495.8	151.10
2829	3888	495.7	151.10
2831	3888	494.2	150.65
2835	3889	493.9	150.55
2838	3890	494.2	150.65
2842	3891	494.6	150.75
2846	3892	495.9	151.15
2850	3893	495.9	151.15
2854	3893	495.5	151.05
2858	3892	494.2	150.65
2858	3888	495.4	151.00
2858	3884	494.3	150.65
2859	3880	494.5	150.70
2859	3875	498.1	151.80

2859	3871	496.1	151.20
2860	3867	495.9	151.15
2860	3862	496.9	151.45
2862	3891	494.9	150.85
2865	3889	494.7	150.80
2868	3888	494.7	150.80
2872	3887	494.3	150.65
2876	3886	494.8	150.80
2880	3886	494.0	150.55
2884	3885	493.6	150.45
2888	3885	493.7	150.50
3892	3885	493.5	150.40
2896	3885	493.6	150.45
2900	3885	492.4	150.10
2902	3882	493.2	150.35
2903	3878	492.9	150.25
2903	3874	491.7	149.85
2904	3870	491.8	149.90
2905	3866	491.9	149.95
2905	3864	492.2	150.00
2908	3866	493.1	150.30
2912	3879	492.3	150.05
2912	3883	491.8	149.90
2916	3883	491.7	149.85
2921	3884	492.6	150.15
2924	3885	491.9	149.95
2928	3886	491.9	149.95
2932	3887	491.3	149.75
2936	3888	491.6	149.85
2940	3889	492.2	150.00
2942	3887	492.0	149.95
2945	3885	491.1	149.70
2948	3881	491.1	149.70
2950	3879	489.7	149.25
2944	3888	491.2	149.70
2948	3888	491.0	149.65
2952	3889	490.6	149.55
2957	3889	490.3	149.45
2961	3889	489.1	149.10
2965	3889	488.6	148.95
2969	3889	488.5	148.90

F 286

2755	3978	531.9	162.10
2760	3977	528.5	161.10
2765	3977	527.3	160.70
2769	3976	524.7	159.95
2774	3976	524.4	159.85
2778	3975	524.1	159.75
2781	3977	523.5	159.55
2785	3978	524.0	159.70
2789	3979	524.8	159.95

F 288

2726	3968	505.3	154.00
2731	3967	505.3	154.00
2735	3966	504.7	153.85
2738	3963	504.5	153.75
2741	3960	504.6	153.80
2745	3958	503.8	153.55
2749	3956	502.9	153.30
2753	3954	503.9	153.60
2758	3952	503.8	153.55
2757	3957	503.3	153.40
2756	3961	503.0	153.30
2759	3948	503.5	153.45
2763	3946	503.2	153.40
2767	3943	502.5	153.15
2771	3941	501.5	152.85
2775	3938	500.4	152.50
2777	3934	500.4	152.50
2780	3929	500.8	152.65
2783	3926	501.1	152.75

F 289

2988	3898	489.9	149.30
2990	3902	489.0	149.05
2993	3905	488.6	148.90
2995	3907	488.8	149.00
2997	3910	488.6	148.90
3000	3914	487.9	148.70
3000	3918	487.4	148.55
3005	3920	487.1	148.45
3010	3922	486.4	148.25
3015	3923	485.3	147.90
3020	3922	485.6	148.00
3025	3920	485.6	148.00
3030	3919	484.6	147.70
3035	3917	483.5	147.40
3040	3916	483.8	147.45
3045	3915	482.0	146.90
3050	3915	482.5	147.05
3050	3912	481.0	146.60
3050	3917	483.0	147.20
3055	3916	483.9	147.50
3060	3916	482.6	147.10
3064	3917	482.3	147.00
3069	3917	483.0	147.20
3073	3918	482.7	147.15
3074	3913	482.0	146.90
3075	3909	480.7	146.50
3077	3905	481.8	146.85
3074	3904	480.9	146.55
3078	3900	481.0	146.60

3080	3895	478.6	145.85
3082	3890	480.0	146.30
3084	3886	478.3	145.80
3086	3883	478.4	145.80
3083	3880	479.1	146.05
3080	3878	478.8	145.95
3088	3878	478.7	145.90
3090	3873	478.6	145.85
3090	3868	478.7	145.90
3089	3863	478.8	145.95
3089	3858	479.9	146.25
3088	3853	479.2	146.05
3087	3848	478.9	145.85
3082	3848	478.6	145.85
3077	3848	476.9	145.35
3086	3843	478.0	145.70
3086	3838	477.6	145.55
3086	3833	476.4	145.20
3085	3828	477.4	145.50
3085	3823	476.9	145.35
3085	3818	475.8	145.00
3085	3813	475.6	144.95
3084	3808	475.0	144.75
3082	3804	475.2	144.85
3080	3800	475.0	144.75

3076	3827	477.0	145.40
3072	3825	476.5	145.25
3069	3822	476.0	145.05
3065	3820	478.9	145.95
3077	3822	477.3	145.50
3077	3816	476.8	145.30
3078	3811	477.4	145.50
3078	3805	476.9	145.35
3077	3800	475.9	145.05
3075	3794	475.2	144.85
3073	3789	474.0	144.45
3071	3785	473.8	144.40
3070	3781	473.5	144.30
3069	3776	474.0	144.45
3068	3771	473.3	144.25

F 290

2724	3955	504.4	153.75
2724	3958	504.6	153.80
2725	3962	504.9	153.90
2725	3951	503.6	153.50
2727	3947	503.9	153.60
2729	3944	504.0	153.60
2732	3940	502.6	153.20
2735	3937	503.4	153.45
2738	3934	503.1	153.35
2742	3932	502.2	153.05
2746	3930	500.9	152.65

2750	3928	501.3	152.80
2754	3927	501.8	152.95
2759	3926	501.4	152.85
2762	3925	500.5	152.55
2766	3924	500.1	152.45
2770	3922	500.1	152.45
2774	3920	499.9	152.35
2778	3918	499.9	152.35
2782	3916	499.7	152.30
2786	3913	499.6	152.30
2790	3912	500.0	152.40
2794	3910	498.7	152.00
2799	3909	498.5	151.95
2803	3908	498.6	151.95
2806	3905	497.7	151.70
2810	3902	497.0	151.50
2815	3902	497.1	151.50
2819	3902	497.1	151.50
2822	3901	498.0	151.80
2826	3902	497.6	151.65
2826	3907	496.8	151.40
2826	3912	496.7	151.40
2829	3903	496.3	151.25
2833	3904	495.2	150.95
2836	3905	494.7	150.80

F 291

3009	3904	504.3	153.70
3013	3906	502.6	153.20
3018	3908	502.5	153.15
3023	3908	502.9	153.30
3027	3906	502.4	153.11
3031	3903	501.7	152.95
3035	3900	501.4	152.80
3038	3896	500.7	152.60
3041	3893	499.6	152.30
3045	3891	498.1	151.80
3049	3889	496.6	151.35
3056	3881	499.1	152.15
3058	3877	499.4	152.20
3060	3873	499.0	152.10
3061	3868	497.7	151.70
3063	3864	495.8	151.10
3059	3861	493.2	150.35
3056	3858	491.7	149.85
3065	3861	494.9	150.85
3067	3856	493.1	150.30

F 292

2769	3958	521.5	158.95
2776	3949	518.9	158.15
2778	3954	518.0	157.90
2781	3958	518.0	157.90

2782	3949	518.2	157.95
2785	3950	517.3	157.65
2788	3952	518.1	157.90
2792	3954	518.3	158.00
2795	3956	519.0	158.20
2800	3958	519.0	158.20
2804	3959	519.0	158.20
2809	3959	519.8	158.45

F 293

3077	3874	493.1	150.30
3078	3870	492.3	150.05
3077	3865	489.4	149.15
3076	3861	489.0	149.05
3075	3856	487.7	148.65
3073	3851	486.0	148.15
3070	3846	483.8	147.45
3070	3840	482.8	147.15
3070	3835	482.6	147.10
3068	3836	481.8	146.85
3069	3830	481.1	146.60
3067	3827	477.8	145.65

F 294

2784	3940	509.4	155.25
2788	3939	509.1	155.15
2793	3938	508.3	154.95
2797	3937	508.7	155.05
2801	3936	507.9	154.80
2805	3936	507.8	154.80
2809	3935	508.6	155.00
2809	3930	508.2	154.90
2808	3926	508.8	155.10
2813	3934	507.9	154.80
2818	3933	507.4	154.65

F 295

3053	3883	499.0	152.10
3051	3882	500.1	152.40
3054	3829	498.7	152.00
3055	3825	497.4	151.60
3056	3821	495.5	151.05
3057	3817	494.4	150.70

F 296

2869	3901	518.9	158.15
2881	3906	518.5	158.05
2886	3907	518.8	158.15
2885	3910	521.7	159.00
2891	3908	517.1	157.60
2896	3908	518.4	158.00
2901	3910	519.1	158.20

F 297

3059	3813	483.8	147.45
3060	3811	484.3	147.60
3063	3807	486.3	148.20
3060	3806	486.2	148.20
3063	3802	484.5	147.65
3062	3797	480.9	146.55

F 298

2873	3895	496.5	151.35
2878	3894	496.7	151.40
2883	3893	498.3	151.90
2888	3892	497.6	151.65
2888	3896	494.6	150.75
2892	3892	495.4	151.00
2896	3892	493.5	150.40
2901	3892	492.8	150.20
2906	3892	492.5	150.10
2910	3893	492.3	150.05

F 299

3120	3706	470.6	143.45
3124	3703	470.7	143.45
3127	3701	471.2	143.60
3130	3698	470.2	143.30
3134	3698	470.6	143.45
3138	3697	470.2	143.30
3142	3696	469.7	143.15
3147	3695	470.2	143.30
3151	3693	469.6	143.15
3156	3691	469.2	143.00
3161	3689	468.7	142.85
3165	3687	468.4	142.75
3169	3685	468.2	142.70
3173	3683	467.5	142.50
3176	3688	465.7	141.95
3170	3679	467.9	142.60
3167	3675	467.8	142.60
3164	3671	467.1	142.35
3161	3667	466.0	142.05
3176	3680	467.0	142.35
3180	3677	466.9	142.30
3183	3674	466.6	142.20
3186	3671	466.9	142.30
3190	3668	466.8	142.30
3193	3665	466.5	142.20
3196	3662	466.1	142.05
3200	3659	465.8	142.00
3201	3655	465.5	141.90
3204	3651	465.7	141.95

3207	3647	465.2	141.80
3210	3642	465.7	141.95
3213	3640	464.6	141.60
3217	3636	464.1	141.45
3220	3633	464.1	141.45
3222	3629	463.5	141.25
3225	3625	462.6	141.00
3228	3622	462.2	140.90
3231	3619	461.8	140.75
3234	3614	461.6	140.70
3236	3610	462.9	141.10
3239	3606	462.1	140.85
3242	3603	461.1	140.55
3245	3600	461.4	140.65
3248	3597	461.3	140.60
3245	3594	460.8	140.45
3243	3590	460.5	140.35
3240	3587	459.6	140.10
3238	3585	459.8	140.15
3250	3593	460.6	140.40
3253	3590	461.0	140.50
3256	3586	460.5	140.35
3260	3584	459.9	140.20
3264	3581	459.9	140.20
3266	3587	459.9	140.20
3271	3886	460.6	140.40
3275	3584	459.7	140.10
3279	3582	460.2	140.25
3284	3581	460.2	140.25
3288	3580	459.4	140.05
3292	3578	459.4	140.05
3296	3576	458.6	139.80
3300	3575	458.6	139.80
3303	3573	458.4	139.70
3309	3571	459.0	139.90
3314	3571	459.3	140.00
3318	3573	459.0	139.90

F 300

2902	3905	509.0	155.15
2907	3897	509.7	155.35
2913	3899	508.0.	154.85
2917	3900	506.4	154.35
2921	3901	508.9	155.10
2924	3904	509.4	155.25
2924	3908	506.1	154.25
2923	3911	507.7	154.75
2927	3903	507.5	154.70
2931	3905	507.4	154.65
2935	3906	507.1	154.55
2939	3908	505.2	154.00
2943	3910	500.8	152.65

F 301

3133	3587	483.4	147.35
3134	3583	484.0	147.50
3135	3580	483.7	147.45
3136	3576	483.8	147.45

F 302

2917	3891	491.9	149.95
2922	3892	491.3	149.75
2926	3893	491.2	149.70
2930	3895	491.0	149.65
2934	3896	490.0	149.35
2938	3897	489.0	149.00

F 304

2932	3920	511.9	156.05
2937	3920	513.8	156.60
2939	3923	513.4	156.50

F 305

3230	3583	468.5	142.80
3233	3579	469.2	143.00
3236	3576	470.6	143.45
3239	3572	469.4	143.05
3244	3568	464.0	141.45
3247	3565	464.8	141.65

F 306

2942	3921	506.0	154.25
2946	3922	507.0	154.55
2950	3923	506.4	154.35

F 307

3245	3525	547.2	166.80
3247	3529	542.9	165.50
3249	3533	540.6	164.75
3250	3537	539.5	164.45
3251	3541	538.5	164.15
3253	3544	537.2	163.75
3257	3543	536.8	163.60
3256	3548	535.5	163.15

F 308

2958	3932	508.4	154.95
2962	3935	508.5	155.00
2966	3938	505.8	154.15

2956	3922	508.5	155.00
2960	3924	508.1	154.85
2960	3928	508.2	154.90

F 309

3258	3522	543.6	165.70
3262	3522	540.2	164.65
3266	3525	537.3	163.75
3269	3527	537.2	163.75

F 310

2922	3896	493.3	150.35
2926	3897	491.1	149.70
2930	3898	491.5	149.80
2933	3899	490.6	149.55
2937	3900	490.2	149.40
2941	3900	490.1	149.40
2944	3901	489.9	149.30
2944	3903	489.8	149.30
2948	3899	489.2	149.10
2953	3898	489.5	149.20
2958	3897	488.1	148.75
2963	3896	488.7	148.95
2968	3895	488.9	149.00
2973	3896	488.5	148.90
2972	3901	488.0	148.75
2971	3906	487.2	148.50
2970	3910	487.1	148.45
2968	3915	487.1	148.45
2967	3920	487.1	148.45
2978	3898	488.1	148.75
2982	3902	487.7	148.65
2986	3905	489.0	149.05
2989	3909	487.2	148.50
2985	3913	486.0	148.15
2982	3918	486.9	148.40
2991	3915	487.3	148.55
2992	3920	487.1	148.45
2994	3925	485.9	148.10

F 312

2972	3935	504.3	153.70
2975	3938	503.0	153.30
2973	3941	502.8	153.25
2971	3943	504.1	153.65
2978	3935	501.8	152.95
2980	3932	501.6	152.90
2980	3939	499.7	152.30
2964	3940	497.9	151.75
2988	3941	497.9	151.75
2992	3942	497.9	151.75
2997	3943	500.4	152.50
2998	3939	500.6	152.60
2995	3946	500.6	152.60
2994	3950	499.9	152.35
2992	3954	499.5	152.25
3002	3944	499.2	152.15
3008	3945	498.2	151.85
3017	3947	493.8	150.50
3023	3948	494.3	150.65
3027	3949	497.7	151.70
3032	3950	501.4	152.85
3031	3950	501.5	152.85
3033	3946	499.0	152.10
3034	3951	503.0	153.30
3039	3952	504.7	153.85

F 313

3305	3515	479.7	146.20
3309	3512	479.0	146.00
3301	3514	479.6	146.20
3298	3516	481.1	146.65
3294	3517	482.6	147.10
3306	3517	477.4	145.50
3307	3521	475.8	145.00
3308	3525	474.2	144.55
3309	3529	472.4	144.00
3310	3534	470.7	143.45
3311	3538	467.6	142.50
3312	3542	465.9	142.00
3313	3546	464.1	141.45
3314	3550	462.1	140.85
3315	3554	461.3	140.60
3316	3558	460.9	140.50
3316	3563	461.1	140.55
3317	3567	459.2	139.95

F 314

2968	3924	499.8	152.35
2972	3924	499.0	152.10
2976	3925	499.6	152.30
2975	3927	499.8	152.35
2980	3926	499.3	152.20
2984	3927	499.0	152.10

F 315

3321	3575	460.2	140.25
3324	3578	459.6	140.10
3327	3581	459.3	140.00
3330	3585	458.5	139.75
3333	3588	458.6	139.80
3336	3592	458.2	139.65

3340	3597	458.9	139.85
3341	3595	454.8	138.60
3344	3591	454.9	138.65
3346	3587	454.7	138.60
3348	3583	454.8	138.60
3351	3579	454.4	138.50
3353	3575	454.7	138.60
3355	3571	453.9	138.35
3341	3601	457.2	139.35
3345	3603	457.1	139.30
3349	3605	456.6	139.15
3353	3607	455.6	138.85
3357	3608	455.8	138.95
3361	3608	455.1	138.70
3366	3608	454.9	138.65
3370	3608	453.4	138.20
3374	3607	454.1	138.40

F 316

3018	3931	486.1	148.15
3022	3930	485.5	148.00
3027	3928	485.2	147.90
3031	3925	484.4	147.65
3035	3923	483.7	147.45
3039	3922	484.5	147.70
3040	3926	483.7	147.45
3040	3930	483.4	147.35
3044	3923	483.9	147.50
3050	3923	483.4	147.35
3055	3924	482.9	147.20
3060	3926	482.0	146.90
3064	3929	480.7	146.50
3068	3933	482.1	146.95

F 317

3394	3645	450.5	137.30
3397	3648	450.5	137.30
3400	3651	450.3	137.25
3402	3654	449.8	137.10
3404	3657	449.6	137.05
3406	3660	449.4	137.00
3410	3663	449.0	136.85
3413	3666	448.2	136.60
3416	3669	448.1	136.60
3420	3672	448.8	136.80
3423	3675	448.7	136.75
3425	3678	448.4	136.65
3428	3681	449.0	136.85
3431	3684	449.0	136.85
3435	3687	448.4	136.65
3439	3689	447.7	136.45
3443	3690	445.7	135.85
3446	3691	446.1	136.00
3450	3692	445.8	135.90
3554	3693	446.1	136.00
3459	3694	445.6	135.80
3463	3695	445.1	135.65
3466	3696	444.8	135.60
3470	3697	443.5	135.20
3474	3698	444.0	135.35
3478	3699	444.5	135.50
3481	3700	444.2	135.40
3484	3700	443.3	135.10
3489	3699	442.2	134.80
3489	3695	441.1	134.45
3490	3691	442.3	134.80
3490	3686	441.9	134.70
3490	3681	440.9	134.40
3494	3698	442.9	135.00
3498	3696	442.5	134.85
3502	3694	442.5	134.85
3506	3694	442.2	134.80
3511	3695	441.5	134.55
3516	3698	441.1	134.45
3520	3700	440.2	134.15
3524	3703	439.7	134.00
3527	3706	439.9	134.10
3531	3709	439.7	134.00
3535	3711	438.6	133.70
3539	3714	437.8	133.45
3542	3716	437.2	133.25
3546	3718	437.1	133.25
3551	3719	436.1	132.90
3555	3718	436.1	132.90
3559	3716	435.6	132.75
3563	3713	434.8	132.55
3566	3710	434.3	132.35
3569	3707	433.8	132.20
3572	3703	433.3	132.05
3575	3700	434.6	132.45
3578	3697	434.4	132.40
3581	3693	435.3	132.70
3585	3691	435.4	132.70
3590	3690	436.3	133.00
3594	3689	435.3	132.70
3599	3690	434.2	132.35
3603	3691	433.6	132.15
3612	3678	432.8	131.90
3616	3678	432.4	131.80
3620	3679	430.7	131.30
3624	3680	431.6	131.55
3627	3682	432.1	131.70
3626	3685	431.4	131.50
3629	3678	430.6	131.25
3631	3675	429.4	130.90
3632	3673	432.1	131.70
3630	3683	431.0	131.35
3634	3685	430.9	131.35

3635	3685	431.4	131.50
3644	3695	426.9	130.10
3648	3697	427.3	130.25
3651	3699	426.9	130.10
3654	3701	426.8	130.10
3658	3703	426.8	130.10
3662	3704	426.9	130.10
3666	3706	425.7	129.75
3670	3700	428.0	130.45
3670	3708	427.2	130.20
3674	3709	427.4	130.25
3678	3710	426.6	130.05
3682	3711	425.4	129.65
3686	3712	425.5	129.70
3689	3713	425.7	129.75
3691	3709	426.1	129.90
3693	3706	425.8	129.80
3695	3702	426.6	130.05
3693	3713	424.8	129.50
3697	3715	426.8	130.10
3701	3716	426.3	129.95
3705	3718	425.4	129.65
3709	3720	424.3	129.35
3713	3722	424.9	129.50
3715	3723	424.8	129.50

F 318

3032	3933	484.4	147.65
3037	3934	490.3	149.45
3042	3936	496.5	151.35

F 320

3078	3924	482.3	147.00
3079	3919	481.5	146.75
3080	3914	481.4	146.75
3082	3909	481.3	146.70
3084	3905	480.9	146.60
3086	3906	480.6	146.50
3085	3901	480.4	146.45
3087	3896	480.0	146.30
3088	3891	479.3	146.10
3090	3887	478.9	146.00
3092	3883	478.2	145.75

F 321

3662	3676	450.1	137.20
3663	3679	446.3	136.05
3663	3683	443.0	135.05
3664	3685	439.2	133.85
3666	3687	438.6	133.70
3668	3689	439.2	133.85
3668	3688	441.7	134.65
3669	3687	444.4	135.45
3669	3685	447.6	136.45
3670	3684	450.1	137.20
3671	3683	452.5	137.90
3671	3691	439.0	133.80
3675	3692	436.9	133.15
3678	3692	437.2	133.25
3682	3692	435.3	132.70
3685	3692	434.4	132.40
3687	3691	433.9	132.25
3690	3691	439.2	133.85

F 322

3081	3793	473.6	144.35
3079	3788	473.7	144.40
3077	3784	473.1	144.20
3075	3779	472.4	144.00
3074	3774	472.7	144.10
3074	3769	472.9	144.15
3074	3765	472.6	144.05
3078	3765	471.8	143.80
3081	3765	472.0	143.85
3074	3760	472.2	143.95
3075	3755	471.7	143.75
3076	3750	471.8	143.80
3078	3745	471.6	143.75
3081	3741	470.8	143.50
3084	3738	471.3	143.65
3088	3735	471.1	143.60
3092	3732	470.9	143.55
3096	3729	470.2	143.30
3100	3726	468.7	142.85
3104	3723	469.4	143.05
3108	3721	468.3	142.75
3112	3718	468.4	142.75
3117	3715	468.1	142.70
3121	3713	467.9	142.60
3126	3710	468.0	142.65
3130	3708	467.7	142.55
3135	3705	467.6	142.50
3140	3703	467.2	142.40
3144	3701	467.4	142.45
3148	3700	467.3	142.45
3153	3699	466.6	142.20
3157	3698	466.5	142.20
3161	3697	466.6	142.20

F 323

3722	3725	463.4	141.25
3725	3728	466.0	142.05
3728	3724	461.8	140.75
3731	3721	466.1	142.05
3729	3730	463.8	141.35

F 324

3088	3788	486.4	148.25
3087	3784	487.0	148.45
3088	3779	487.2	148.50
3088	3774	488.4	148.85
3093	3775	485.5	148.00
3089	3769	487.8	148.70
3090	3763	487.2	148.50
3091	3758	486.2	148.20
3091	3753	485.0	147.85
3094	3757	482.5	147.05
3097	3761	480.5	146.45
3100	3765	478.2	145.75
3091	3748	484.1	147.55

F 325

3731	3736	459.7	140.10
3735	3738	457.4	139.40
3740	3739	457.8	139.55
3745	3740	458.9	139.85

F 326

3084	3761	477.4	145.50
3087	3757	476.7	145.30
3085	3757	477.7	145.60
3087	3753	477.8	145.65

F 327

3741	3745	425.9	129.80
3745	3747	424.7	129.45
3749	3748	424.9	129.50
3753	3750	423.1	128.95
3757	3752	423.4	129.05
3761	3754	422.9	128.90
3765	3756	422.5	128.80
3770	3758	421.2	128.40
3774	3759	420.4	128.15
3779	3761	421.5	128.45
3782	3764	421.8	128.55
3783	3759	421.2	128.40
3786	3766	420.9	128.30
3790	3768	421.2	128.40
3794	3770	421.5	128.45
3799	3771	420.6	128.20
3803	3771	420.4	128.15
3807	3770	420.1	128.05
3812	3769	419.6	127.90
3816	3768	419.1	127.75
3821	3767	418.6	127.60
3825	3765	418.3	127.50
3828	3762	418.3	127.50
3831	3759	418.1	127.45
3833	3756	417.4	127.20

F 328

3107	3741	479.4	146.10
3109	3738	479.7	146.20
3112	3735	478.9	145.95

F 329

3762	3738	469.0	142.95
3766	3740	465.2	141.80

F 330

3117	3738	483.9	147.50
3118	3735	484.4	147.65
3121	3732	483.0	147.20
3119	3729	481.5	146.75
3125	3729	480.7	146.50

F 331

3784	3745	458.9	139.85
3784	3740	458.2	139.65
3799	3744	447.6	136.45

F 332

3135	3738	483.7	147.45
3136	3735	484.4	147.65
3138	3732	487.1	148.45
3143	3723	492.8	150.20
3147	3721	492.1	150.00
3152	3718	494.7	150.80
3153	3720	494.9	150.85
3156	3717	494.0	150.55
3161	3716	491.1	149.70

F 333

3937	3728	412.0	125.60
3941	3726	411.1	125.30
3945	3724	411.5	125.45
3950	3722	412.1	125.60
3955	3720	411.6	125.45
3953	3717	411.3	125.35
3960	3718	411.2	125.35
3963	3715	410.8	125.20
3966	3711	410.6	125.15
3968	3706	411.3	125.35
3970	3702	409.5	124.80
3972	3698	409.7	124.90
3974	3693	409.3	124.75

3976	3688	409.1	124.70
3978	3684	409.4	124.80
3979	3679	408.5	124.50
3980	3675	408.2	124.40
3982	3667	406.4	123.85
3984	3663	406.9	124.00

F 334

3105	3724	473.6	144.35
3109	3722	472.6	144.05
3113	3719	472.1	143.90
3118	3716	471.1	143.60
3122	3713	471.3	143.65
3127	3711	470.3	143.35
3132	3709	469.7	143.15
3134	3711	471.2	143.60
3137	3715	471.3	143.65
3138	3717	471.2	143.60
3137	3710	469.4	143.05
3140	3709	469.3	143.05
3144	3708	469.4	143.05
3148	3707	469.2	143.00
3152	3706	469.0	142.95
3155	3705	470.4	143.40
3158	3703	472.3	143.95
3162	3701	472.2	143.95
3165	3699	471.8	143.80
3168	3698	470.5	143.40
3172	3696	469.8	143.20
3175	3694	468.8	142.90
3178	3693	468.1	142.70
3182	3691	468.0	142.65
3185	3689	468.2	142.70
3188	3687	467.8	142.60
3191	3685	466.9	142.30
3194	3682	466.8	142.30

F 335

3942	3717	466.3	142.15
3946	3714	466.1	142.05
3949	3710	462.9	141.10
3952	3706	461.8	140.75
3954	3702	460.7	140.40
3957	3706	460.4	140.35
3961	3702	459.6	140.10

F 336

3239	3624	463.1	141.15
3241	3621	463.5	141.25
3243	3618	463.6	141.30
3245	3615	462.7	141.05
3247	3612	462.1	140.85
3250	3609	462.1	140.85
3252	3605	462.0	140.80
3255	3602	462.2	140.90
3258	3600	461.8	140.75
3261	3598	460.7	140.40
3265	3595	460.4	140.35
3269	3593	460.5	140.35
3272	3591	460.5	140.35
3276	3590	460.5	140.35
3279	3589	460.1	140.25
3283	3588	458.7	139.80
3287	3586	460.6	140.40
3290	3585	460.0	140.20
3294	3583	459.9	140.20
3297	3581	459.7	140.10
3301	3580	459.3	140.00
3305	3578	459.4	140.05
3309	3577	459.4	140.05
3313	3577	459.5	140.05
3317	3579	458.5	139.75
3320	3582	458.5	139.75
3316	3585	455.5	138.85
3313	3588	456.3	139.10
3309	3591	457.1	139.30
3306	3594	456.1	139.00
3322	3585	458.4	139.70
3325	3588	458.6	139.80
3328	3591	458.5	139.75
3331	3594	457.6	139.50
3333	3598	457.3	139.40

F 338

3255	3620	472.2	143.95
3258	3618	473.5	144.30
3262	3617	473.6	144.35
3265	3616	473.8	144.40
3269	3615	473.6	144.35
3273	3613	473.5	144.30
3277	3611	473.0	144.15
3281	3609	472.4	144.00
3285	3608	472.2	143.95
3289	3607	473.1	144.20
3292	3606	473.1	144.20
3292	3610	471.7	143.75
3292	3614	472.5	144.00
3293	3618	470.9	143.55
3293	3622	471.2	143.60
3293	3626	470.7	143.45
3294	3630	471.7	143.75
3294	3634	471.9	143.85
3294	3637	472.7	144.10
3296	3605	472.5	144.00
3300	3604	471.2	143.60
3304	3603	471.6	143.75

3307	3606	471.3	143.65
3310	3608	470.9	143.55
3310	3611	470.4	143.40
3313	3613	470.8	143.50
3316	3616	471.6	143.75
3320	3618	470.9	143.55
3330	3609	468.5	142.80
3333	3611	466.3	142.15
3337	3612	464.3	141.50

F 339

4170	3629	399.6	121.80
4172	3630	399.6	121.80
4175	3631	399.3	121.70
4179	3631	398.2	121.35
4182	3630	397.1	121.05
4185	3628	398.2	121.35
4188	3625	398.0	121.30
4191	3623	396.8	120.95

F 340

3285	3593	469.1	143.00
3285	3598	467.3	142.45
3288	3592	464.8	141.65
3293	3592	464.5	141.60
3292	3595	463.3	141.20

F 342

3322	3696	487.3	148.55
3324	3691	485.4	147.95
3324	3686	483.3	147.30
3323	3682	482.2	146.95
3323	3677	481.1	146.65
3321	3674	479.7	146.20
3318	3672	479.0	146.00
3315	3669	477.6	145.55
3316	3665	476.2	145.15
3316	3661	475.1	144.80
3317	3657	474.4	144.60
3314	3654	472.8	144.10
3310	3652	471.5	143.70
3306	3649	470.4	143.40
3302	3646	469.3	143.05
3319	3653	473.1	144.20
3321	3650	471.9	143.85

F 343

4160	3611	423.9	129.20
4163	3613	421.6	128.50
4166	3615	419.6	127.90
4171	3617	419.0	127.70

F 344

3336	3601	457.0	139.30
3339	3605	457.6	139.50
3342	3608	457.0	139.30
3346	3611	456.4	139.10
3349	3613	456.4	139.10
3353	3615	456.3	139.10
3357	3616	455.3	138.80
3362	3616	455.4	138.80
3366	3616	454.8	138.60
3363	3619	455.1	138.70
3361	3623	455.1	138.70
3358	3626	456.8	139.25
3355	3629	458.6	139.80
3370	3618	455.9	138.95

F 346

3381	3628	453.5	138.25
3383	3633	452.6	137.95
3385	3636	452.5	137.90
3387	3640	452.5	137.90
3389	3643	452.1	137.80
3391	3647	451.5	137.60
3394	3650	449.7	137.05
3397	3654	450.3	137.25
3400	3658	449.9	137.15

F 347

4176	3607	493.6	150.45
4181	3607	491.7	149.85
4185	3607	490.2	149.40
4189	3606	490.7	149.55
4187	3602	492.8	150.20
4192	3601	491.8	149.90
4197	3600	490.5	149.50
4201	3598	490.1	149.40
4205	3595	488.2	148.80
4209	3592	486.2	148.20
4212	3589	484.5	147.70
4215	3587	482.9	147.20
4218	3585	482.0	146.90
4221	3583	482.6	147.10
4225	3581	480.2	146.35
4229	3579	479.3	146.10
4232	3577	478.0	145.70
4236	3575	478.9	145.95
4246	3568	474.9	144.75
4251	3565	474.9	144.75
4254	3562	475.0	144.80
4256	3558	472.9	144.15

F 348

3405	3663	450.3	137.25
3408	3666	449.6	137.05
3410	3670	449.9	137.15
3413	3674	450.0	137.15
3415	3678	449.8	137.10
3411	3680	448.8	136.80
3408	3683	448.4	136.65
3404	3686	448.6	136.75
3401	3689	449.5	137.00
3398	3692	448.4	136.65
3394	3694	448.4	136.65
3391	3697	448.0	136.55
3418	3681	449.5	137.00
3421	3685	449.1	136.90
3424	3688	448.3	136.65
3427	3692	448.4	136.65
3430	3695	447.1	136.30
3434	3696	447.5	136.40
3438	3697	447.8	136.50
3442	3699	447.4	136.35
3447	3700	447.0	136.25
3452	3700	446.9	136.20
3457	3701	445.0	135.65
3461	3701	445.3	135.75
3465	3702	444.9	135.60
3470	3703	443.8	135.25
3474	3705	443.5	135.20
3477	3707	443.5	135.20
3478	3711	442.4	134.85
3478	3715	442.8	134.95
3478	3719	442.3	134.80
3478	3723	441.8	134.65
3478	3727	441.4	134.55
3478	3731	441.1	134.45
3482	3715	442.5	134.85
3486	3715	442.4	134.85
3490	3714	442.7	134.95
3494	3714	442.7	134.95
3498	3713	442.2	134.80
3501	3713	442.1	134.75
3501	3709	441.1	134.45
3502	3705	441.8	134.65
3500	3717	441.8	134.65
3499	3721	440.2	134.15
3498	3725	440.1	134.15
3508	3706	440.5	134.25
3512	3709	441.4	134.55
3516	3712	441.7	134.65
3520	3714	440.6	134.30
3524	3716	440.3	134.20
3527	3719	439.7	134.00
3531	3721	439.2	133.85
3535	3723	439.5	133.95
3539	3725	439.8	134.05
3537	3720	439.1	133.85
3541	3721	438.8	133.75
3545	3722	439.3	133.90
3549	3723	438.6	133.70
3554	3723	438.5	133.65
3558	3722	438.1	133.55
3561	3719	438.1	133.55
3565	3717	437.5	133.35
3568	3714	437.3	133.30
3572	3711	436.9	133.15
3575	3708	436.2	132.95

F 349

4195	3609	452.5	137.90
4199	3606	450.0	137.15
4203	3603	448.5	136.70
4207	3600	448.7	136.76
4210	3597	445.6	135.80
4215	3594	445.2	135.70
4217	3597	444.8	135.60
4221	3594	445.9	135.90
4223	3591	444.2	135.40

F 350

3363	3678	467.2	142.40
3366	3683	466.0	142.05
3366	3684	467.0	142.35
3367	3685	466.8	142.30
3368	3685	466.9	142.30
3368	3684	467.8	142.60
3367	3684	465.6	141.90
3367	3683	463.4	141.25
3366	3685	466.5	142.20
3365	3686	466.4	142.15
3365	3687	466.3	142.15
3364	3687	466.5	142.20
3363	3687	466.4	142.15
3363	3688	466.2	142.10
3362	3688	465.9	142.00
3362	3689	465.9	142.00
3361	3689	465.8	142.00
3360	3689	465.9	142.00
3367	3687	466.6	142.20
3368	3688	466.9	142.30
3369	3690	467.6	142.50
3370	3691	466.9	142.30
3371	3693	466.5	142.20
3371	3695	465.5	141.90
3374	3698	463.6	141.30
3377	3701	462.9	141.10
3380	3704	464.6	141.60
3382	3707	463.2	141.20

3379	3710	463.4	141.25
3384	3710	461.4	140.60
3387	3712	460.1	140.25

F 351

4228	3689	430.8	131.30
4232	3688	432.4	131.80
4236	3686	432.2	131.75
4235	3683	432.6	131.85
4240	3684	431.4	131.50
4245	3681	427.6	130.35
4249	3678	425.9	129.80
4252	3676	424.1	129.25
4256	3673	422.7	128.85
4260	3670	423.1	128.95
4264	3668	422.4	128.75
4266	3664	420.4	128.15

F 352

3677	3720	427.3	130.25
3681	3721	426.9	130.10
3685	3723	426.8	130.10
3689	3724	426.7	130.05
3693	3726	426.6	130.05
3696	3728	425.7	129.75
3700	3730	426.0	129.85
3704	3731	423.9	129.20
3708	3733	426.0	129.85
3711	3735	425.3	129.65
3715	3737	425.2	129.60
3718	3739	423.4	129.05
3721	3742	425.7	129.75
3724	3745	424.9	129.50
3726	3742	423.4	129.05
3722	3749	424.7	129.45
3720	3753	423.0	128.95
3727	3748	424.8	129.50
3731	3751	424.0	129.25
3734	3755	423.8	129.15
3738	3757	423.7	129.15
3741	3759	423.0	128.95
3745	3760	421.6	128.50
3749	3762	421.9	128.60
3753	3763	421.8	128.55
3757	3765	420.7	128.25
3762	3766	420.2	128.10
3766	3768	420.4	128.15
3770	3769	420.4	128.15
3775	3770	421.2	128.40
3779	3771	421.2	128.40
3783	3772	420.7	128.25
3787	3774	420.8	128.25
3791	3776	419.4	127.85

F 253

4256	3582	392.1	119.50
4261	3579	391.0	119.20
4266	3576	391.6	119.35
4271	3573	391.8	119.40
4275	3570	390.6	119.05
4279	3567	390.1	118.90
4275	3564	389.9	118.85
4283	3563	390.6	119.05
4286	3558	390.3	118.95
4289	3554	390.2	118.95
4291	3550	389.6	118.75
4292	3545	389.2	118.65
4295	3540	388.5	118.40
4297	3536	387.4	118.10
4299	3532	387.5	118.10

F 354

3662	3720	448.1	136.60
3666	3722	448.4	136.65
3668	3725	448.4	136.65
3671	3728	448.1	136.60
3673	3731	448.2	136.60

F 355

4266	3547	466.3	142.15
4270	3546	465.1	141.75
4274	3545	463.8	141.35

F 356

3834	3764	417.1	127.15
3836	3760	418.2	127.45
3839	3758	417.1	127.15
3843	3756	417.2	127.15
3847	3755	416.0	126.80
3851	3754	415.5	126.65
3855	3753	415.8	126.75
3859	3752	415.2	126.55
3864	3751	415.1	126.50
3868	3751	414.6	126.35
3871	3750	415.7	126.70
3874	3748	414.5	126.35
3879	3747	414.5	126.35
3883	3746	413.6	126.05
3887	3745	413.5	126.05
3891	3745	412.4	125.70
3895	3744	412.7	125.80
3899	3743	411.9	125.55
3903	3742	412.0	125.60
3907	3741	412.4	125.70
3911	3741	412.7	125.80

3915	3740	412.4	125.70
3919	3739	412.1	125.60
3923	3738	411.9	125.55
3927	3736	411.8	125.50
3931	3735	412.0	125.60
3935	3733	411.6	125.45
3939	3731	411.3	125.35
3944	3730	410.9	125.25

F 357

4369	3503	384.2	117.10
4374	3504	383.6	116.90
4380	3505	382.6	116.60
4385	3505	382.2	116.50
4390	3503	381.0	116.15
4395	3502	381.8	116.35
4400	3501	381.8	116.35
4400	3496	381.3	116.20
4405	3500	381.5	116.30
4409	3498	380.4	115.95
4414	3496	379.8	115.75
4420	3494	379.0	115.50
4423	3492	378.1	115.25

F 359

4369	3492	424.6	129.40
4374	3492	422.7	128.85
4380	3492	422.1	128.65
4385	3490	421.3	128.40
4383	3485	422.1	128.65
4390	3487	420.1	128.05
4395	3485	418.9	127.70

F 360

3983	3685	410.3	125.05
3984	3681	409.3	124.75
3985	3677	408.0	124.35
3986	3672	407.5	124.20
3987	3668	407.1	124.10
3989	3662	408.0	124.35
3992	3658	407.3	124.15
3995	3654	408.4	124.50
3999	3651	407.4	124.20
4002	3650	407.2	124.10
4005	3646	407.1	124.10
4008	3648	407.0	124.05
4010	3644	404.6	123.30
4015	3642	403.7	123.05
4019	3641	404.7	123.35
4035	3636	404.1	123.15
4039	3633	403.7	123.05
4042	3631	404.0	123.15

4046	3628	403.0	122.85
4050	3625	404.2	123.20
4055	3623	403.6	123.00
4060	3622	403.0	122.85
4065	3621	402.1	122.55
4070	3620	401.6	122.40
4074	3619	400.6	122.10

F 361

4377	3494	392.7	119.70
4382	3495	393.8	120.05
4387	3494	394.4	120.20
4392	3493	394.1	120.10
4397	3493	393.6	119.95
4397	3488	393.9	120.05
4402	3492	392.6	119.65
4408	3491	392.1	119.50
4413	3489	391.3	119.25
4419	3488	390.6	119.05
4424	3487	389.0	118.55

F 362

4083	3624	474.3	144.55
4090	3627	471.5	143.70

F 363

4429	3482	384.6	117.25
4434	3482	383.4	116.85
4438	3481	382.5	116.60
4443	3480	381.6	116.30
4447	3480	381.7	116.35
4452	3480	381.2	116.20
4456	3479	379.8	115.75
4461	3479	381.5	116.30

F 364

4019	3663	536.8	163.60
4023	3661	536.5	163.55
4028	3660	534.4	162.90
4033	3660	532.9	162.45
4038	3659	532.4	162.30
4042	3657	533.9	162.75

F 365

4499	3456	422.4	128.75
4502	3454	423.3	129.00
4505	3451	422.6	128.80
4509	3449	422.0	128.65
4513	3447	419.8	127.95

F 366

4096	3628	468.4	142.75

F 367

4512	3440	431.5	131.50
4515	3437	431.1	131.40
4517	3433	431.5	131.50

F 368

4106	3630	468.2	142.70
4111	3630	467.3	142.45
4116	3631	466.2	142.10
4119	3634	462.4	140.95
4117	3639	462.5	140.95
4123	3636	460.6	140.40
4128	3638	456.8	139.25
4134	3639	454.3	138.45
4138	3640	452.3	137.85
4143	3639	449.8	137.10
4147	3639	448.7	136.75
4152	3639	446.0	135.95
4156	3638	443.5	135.20

F 369

4521	3448	369.7	112.70
4524	3446	369.0	112.45
4527	3443	368.7	112.40
4530	3440	369.9	112.75
4533	3437	370.2	112.85
4536	3434	370.4	112.90
4540	3431	368.9	112.45
4543	3428	368.2	112.25
4545	3424	366.7	111.75
4546	3420	365.8	111.50
4546	3415	365.9	111.55
4546	3411	364.0	110.95
4545	3406	364.3	111.05
4545	3401	363.8	110.90
4544	3397	363.0	110.65
4543	3392	362.8	110.60
4543	3388	362.4	110.45
4543	3384	362.5	110.50
4542	3380	362.6	110.50
4542	3376	362.5	110.50
4541	3372	362.5	110.50
4541	3368	362.9	110.60
4540	3363	362.1	110.35
4540	3359	361.6	110.20
4540	3355	361.5	110.20
4539	3351	361.1	110.05
4538	3347	359.9	109.70
4537	3343	359.3	109.50
4535	3340	358.5	109.25
4534	3336	358.7	109.35
4533	3332	358.2	109.20
4532	3328	357.7	109.05
4530	3324	356.9	108.80
4528	3320	356.7	108.70

F 370

4090	3614	402.3	122.60
4095	3612	401.8	122.45
4100	3611	401.9	122.50
4104	3610	400.3	122.00
4109	3610	400.7	122.15
4113	3610	400.9	122.20
4118	3610	401.3	122.30
4122	3611	401.7	122.45
4126	3612	402.3	122.60
4124	3617	401.8	122.45
4131	3613	401.8	122.45
4136	3614	401.5	122.40
4140	3616	401.3	122.30
4144	3619	401.3	122.30
4147	3621	400.0	121.90
4151	3624	399.5	121.75
4155	3626	398.8	121.55
4159	3629	398.9	121.60
4162	3632	397.9	121.30
4166	3634	397.4	121.15
4170	3635	395.9	120.65
4175	3636	395.5	120.55

F 371

4535	3422	380.2	115.90
4537	3418	379.3	115.60
4539	3415	379.2	115.60
4539	3410	379.1	115.55

F 372

4205	3619	396.4	120.80
4209	3616	395.5	120.55
4212	3612	395.6	120.60
4215	3608	395.0	120.40
4219	3605	395.1	120.45
4224	3602	394.3	120.20
4228	3600	394.2	120.15
4230	3604	393.6	119.95
4233	3608	393.3	119.90
4232	3598	393.7	120.00
4236	3596	393.6	119.95
4241	3595	394.4	120.20
4245	3593	393.4	119.90
4250	3591	393.3	119.90
4254	3588	393.0	119.80

4259	3586	392.9	119.75
4263	3584	392.0	119.50
4268	3582	391.4	119.30

F 373

4671	3242	371.1	113.10
4676	3241	371.3	113.15
4681	3240	371.3	113.15
4686	3240	368.4	112.30
4691	3239	367.3	111.95
4692	3241	368.9	112.45
4697	3241	367.9	112.15
4702	3240	366.5	111.70
4706	3239	364.8	111.20
4711	3237	362.7	110.55

F 374

4289	3566	435.6	132.75
4292	3563	434.9	132.55
4295	3560	433.9	132.25
4299	3557	433.0	132.00
4300	3552	433.7	132.20
4302	3549	433.0	132.00
4306	3547	430.8	131.30
4311	3544	427.7	130.35
4316	3542	425.9	129.80

F 376

4306	3529	387.6	118.15
4309	3525	387.5	118.10
4312	3522	387.1	118.00
4315	3520	387.0	117.95
4320	3518	387.6	118.15
4324	3516	387.0	117.95
4328	3515	386.6	117.85
4332	3515	386.0	117.65
4336	3514	386.3	117.75
4341	3513	386.1	117.70
4342	3518	384.3	117.15
4346	3512	386.2	117.70
4350	3511	385.8	117.60
4355	3510	385.8	117.60
4360	3508	385.6	117.55
4365	3509	385.0	117.35
4369	3510	383.0	116.75
4373	3512	381.3	116.20

F 377

4703	3245	344.8	105.10
4708	3244	344.1	104.90
4712	3242	343.7	104.75
4716	3239	343.0	104.55
4721	3236	341.6	104.10

F 378

4364	3518	427.5	130.30
4369	3516	428.1	130.50

F 379

4809	3186	367.0	111.85
4808	3182	363.2	110.70
4807	3178	359.7	109.65
4806	3173	358.7	109.35

F 380

4421	3500	380.1	115.85
4425	3498	379.6	115.70
4429	3496	379.3	115.60
4433	3494	379.6	115.70
4437	3492	378.8	115.45
4442	3490	379.0	115.50
4446	3489	378.6	115.40
4450	3488	379.0	115.50
4454	3487	378.7	115.45
4459	3487	378.6	115.40
4459	3491	376.0	114.60
4464	3487	378.0	115.20
4468	3486	377.3	115.00
4471	3485	375.7	114.50
4475	3483	376.8	114.85
4478	3481	377.0	114.90
4479	3485	380.3	115.90
4480	3490	383.6	116.90
4481	3480	376.4	114.75
4484	3477	375.6	114.50
4488	3475	374.8	114.25
4492	3473	374.1	114.05

F 381

4813	3156	376.7	114.80
4812	3160	375.8	114.55

F 382

4543	3340	360.9	110.00
4542	3336	360.6	109.90
4540	3333	361.1	110.05
4539	3329	360.9	110.00
4537	3325	361.4	110.15
4535	3321	360.8	109.95

4534	3317	360.4	109.85
4534	3312	360.5	109.90
4539	3313	359.0	109.40
4543	3313	357.0	108.80
4535	3308	359.1	109.45
4537	3304	359.3	109.50
4539	3300	358.5	109.25
4541	3296	357.7	109.05
4544	3293	357.5	108.95
4547	3290	357.5	108 .95
4551	3287	356.1	108.55

<u>F 384</u>

4555	3300	416.3	126.90
4559	3297	413.9	126.15
4562	3293	413.2	125.95
4566	3295	411.7	125.50
4570	3298	410.8	125.20
4565	3288	410.5	125.10

<u>F 385</u>

4809	3195	332.8	101.45
4813	3193	333.0	101.50
4817	3192	332.1	101.20
4822	3192	332.7	101.40
4827	3192	332.4	101.30
4831	3194	332.1	101.20
4836	3195	331.6	101.05
4840	3197	330.9	100.85
4845	3198	330.4	100.70
4848	3199	329.6	100.45
4852	3201	328.3	100.05
4856	3203	328.6	100.15
4860	3205	328.4	100.10
4864	3207	328.1	100.00
4868	3209	328.5	100.15
4871	3212	328.4	100.10
4875	3215	327.8	99.90
4878	3217	328.0	99.95
4881	3220	327.9	99.95

4817	3143	338.3	103.10
4819	3146	337.0	102.70
4819	3151	336.0	102.40
4820	3155	334.8	102.05
4821	3159	334.4	101.95
4820	3163	333.2	101.55
4819	3168	332.7	101.40
4817	3172	332.5	101.35
4815	3176	332.6	101.40
4813	3180	332.7	101.40
4812	3184	331.4	101.00
4811	3188	332.0	101.20
4811	3192	332.4	101.30

4822	3143	338.0	103.00
4826	3145	338.3	103.10
4831	3146	336.2	102.45
4835	3148	335.6	102.30
4839	3150	335.8	102.35
4841	3155	335.4	102.25
4849	3157	334.4	101.95
4851	3161	334.5	101.95
4853	3165	333.7	101.70
4855	3168	333.3	101.60
4857	3172	332.8	101.45
4859	3176	332.2	101.25
4861	3180	331.6	101.05
4863	3184	331.2	100.95
4866	3187	330.4	100.70
4868	3190	330.3	100.70
4870	3194	329.7	100.50
4872	3198	329.1	100.30
4874	3201	328.4	100.10
4875	3204	327.9	99.95
4878	3208	327.4	99.80
4880	3211	327.0	99.65
4882	3215	327.5	99.80
4884	3218	327.2	99.75
4886	3222	326.9	99.65

<u>F 386</u>

4568	3281	392.2	119.55
4571	3283	392.4	119.60
4575	3285	394.2	120.15
4580	3285	394.3	120.20
4579	3289	395.8	120.65
4584	3286	394.0	120.10
4588	3284	389.4	118.70
4591	3282	388.5	118.40
4595	3280	386.2	117.70
4599	3280	386.5	117.80
4603	3279	386.3	117.75

<u>F 387</u>

4821	3121	342.7	104.45
4819	3127	340.6	103.80
4817	3124	338.5	103.15
4824	3118	342.7	104.45
4826	3115	342.6	104.40
4824	3124	342.0	104.25
4827	3128	341.7	104.15
4830	3131	340.5	103.80
4834	3134	339.1	103.35
4836	3137	337.4	102.85
4840	3138	336.6	102.60
4845	3140	336.0	102.40
4849	3141	335.5	102.25

F 388

4560	3274	355.9	108.50
4561	3271	356.1	108.55
4563	3268	356.2	108.55
4567	3267	355.2	108.25
4571	3264	356.0	108.50
4575	3261	354.2	107.95
4580	3260	354.1	107.95

F 389

4860	3140	386.0	117.65
4864	3141	383.8	117.00
4867	3143	383.3	116.85
4871	3141	382.0	116.45
4875	3139	383.8	117.00

F 390

4585	3267	354.5	108.05
4590	3266	353.6	107.80
4594	3264	352.9	107.55
4598	3263	352.1	107.30
4602	3262	351.5	107.15
4603	3267	351.0	107.00
4601	3257	352.1	107.30
4600	3255	349.7	106.60
4607	3261	351.6	107.15
4611	3261	351.5	107.15
4616	3260	351.7	107.20
4620	3260	352.6	107.45

F 391

4900	3204	330.4	100.70
4900	3208	330.0	100.60
4901	3212	329.3	100.35
4901	3215	329.9	100.55
4901	3219	329.3	100.35
4900	3223	329.3	100.35
4899	3227	328.6	100.15
4898	3231	327.7	99.90
4899	3235	327.3	99.75
4901	3238	327.5	99.80
4903	3241	327.6	99.85
4906	3244	326.6	99.55

F 392

4595	3273	371.9	113.35
4599	3272	369.9	112.75
4603	3271	370.5	112.95
4608	3271	369.8	112.70
4615	3268	368.2	112.25
4620	3268	367.4	112.00
4624	3267	368.3	112.25
4628	3266	369.3	112.55

F 394

4620	3251	348.5	106.20
4624	3250	348.9	106.35
4628	3250	347.7	106.00
4632	3250	347.2	105.85
4636	3250	346.3	105.55
4640	3250	347.7	106.00
4644	3249	347.8	106.00
4644	3253	347.2	105.85
4644	3257	348.0	106.05
4648	3250	347.2	105.85
4652	3251	346.9	105.75
4656	3252	346.0	105.45
4660	3252	346.0	105.45
4664	3252	345.0	105.15
4668	3251	344.4	104.95
4672	3251	343.8	104.80
4676	3251	344.1	104.90
4676	3254	343.5	104.70
4680	3251	344.2	104.90
4684	3250	343.5	104.70
4688	3250	340.9	103.90
4692	3250	339.9	103.60
4696	3250	339.9	103.60
4700	3251	341.3	104.05
4704	3251	339.4	103.45
4708	3251	340.1	103.65

F 397

4976	3315	343.2	104.60
4980	3317	340.6	103.80
4982	3320	338.9	103.30
4987	3322	336.0	102.40

F 398

4731	3239	339.3	103.40
4735	3237	339.2	103.40
4739	3235	338.5	103.15
4743	3233	338.3	103.10
4746	3231	338.5	103.15
4750	3229	338.0	103.00
4753	3226	337.1	102.75
4758	3225	337.3	102.80
4762	3223	336.6	102.60
4766	3221	335.7	102.30
4770	3218	335.8	102.35
4774	3216	336.6	102.60
4778	3214	335.8	102.35
4781	3212	335.1	102.15
4785	3210	333.8	101.75

4787	3213	333.5	101.65
4788	3215	332.8	101.45
4789	3209	333.0	101.50
4793	3207	333.5	101.65
4798	3206	333.7	101.70
4802	3205	332.8	101.45
4806	3204	332.4	101.30
4810	3203	331.9	101.15
4814	3202	333.3	101.60
4818	3202	332.8	101.45
4822	3201	331.1	100.90
4826	3202	333.0	101.50
4825	3207	331.5	101.05
4825	3210	331.4	101.00
4826	3198	330.7	100.80
4831	3203	331.5	101.05
4831	3204	330.1	100.60
4839	3206	331.0	100.90
4843	3207	331.1	100.90
4846	3208	330.1	100.60
4850	3210	329.3	100.35
4854	3212	329.3	100.35
4857	3215	329.1	100.30
4861	3217	328.1	100.00
4865	3219	328.9	100.25
4868	3221	328.8	100.20
4871	3223	327.2	99.75
4875	3224	325.4	99.20
4878	3225	325.6	99.25

F 399

5038	3387	312.0	95.10
5040	3392	312.8	95.35
5041	3397	312.9	95.35
5042	3401	312.0	95.10
5043	3406	311.5	94.95
5045	3410	310.9	94.75
5047	3414	310.2	94.55
5050	3418	309.7	94.40
5052	3422	309.8	94.45
5055	3426	308.9	94.15

F 401

5054	3404	311.8	95.05
5055	3409	311.6	95.00
5056	3414	311.8	95.05
5057	3419	311.4	94.90
5059	3424	311.3	94.90
5061	3428	311.0	94.80
5064	3432	310.8	94.75
5066	3435	310.9	94.75
5070	3435	307.5	93.75
5069	3439	310.7	94.70

5072	3442	310.3	94.60
5076	3446	309.1	94.20
5080	3450	307.6	93.75
5083	3453	306.9	93.55
5086	3456	306.3	93.35
5090	3459	305.6	93.15
5094	3462	306.7	93.50

F 403

5088	3438	364.8	111.20
5091	3435	363.4	110.75
5092	3439	365.9	111.55
5095	3441	363.8	110.90
5098	3445	363.5	110.80
5101	3448	363.2	110.70
5103	3445	363.0	110.65
5099	3451	360.6	109.90
5097	3454	365.3	111.35
5099	3458	363.6	110.85
5101	3462	365.5	111.40
5103	3465	365.1	111.30
5106	3468	366.1	111.60
5110	3471	365.8	111.50
5114	3470	364.7	111.15
5119	3470	362.1	110.35

F 404

4803	3218	423.6	129.10
4808	3217	421.5	128.45
4812	3219	421.1	128.35

F 405

5112	3432	380.1	115.85
5117	3432	378.4	115.35
5122	3432	377.6	115.10
5126	3433	373.1	113.70
5131	3434	373.4	114.10

F 406

4812	3238	465.4	141.85
4817	3239	461.3	140.60
4822	3240	457.6	139.50

F 407

5112	3475	341.0	103.95
5115	3478	340.7	103.85
5117	3475	339.9	103.60

F 408

4810	3248	483.0	147.20

4815	3249	479.8	146.25
4820	3250	477.3	145.50

F 409

5133	3485	305.9	93.25
5137	3487	304.1	92.70
5142	3489	303.6	92.55
5146	3492	305.5	93.10

F 410

4834	3229	418.1	127.45
4837	3232	418.8	127.65
4840	3235	418.0	127.40
4842	3239	418.0	127.40
4843	3243	417.1	127.15
4838	3243	418.5	127.55
4843	3247	416.7	127.00
4844	3251	416.3	126.90
4845	3254	415.1	126.50
4846	3257	415.6	126.65
4848	3261	414.5	126.35
4850	3264	414.1	126.20
4853	3267	413.1	125.90
4850	3269	413.3	126.00
4855	3270	413.0	125.90
4857	3273	412.2	125.65
4866	3281	407.8	124.30
4870	3282	408.5	124.50
4873	3284	408.1	124.40
4877	3286	407.9	124.35

F 411

5134	3481	306.8	93.50
5138	3482	305.0	92.95
5142	3483	304.6	92.85
5143	3481	303.8	92.60
5147	3485	305.0	92.95
5152	3487	305.9	93.25

F 412

4856	3224	385.4	117.45
4860	3226	386.0	117.65
4864	3228	385.7	117.55
4867	3230	384.8	117.30
4871	3231	386.3	117.75
4869	3235	384.2	117.10
4873	3235	385.7	117.55
4875	3238	383.4	116.85
4879	3240	383.2	116.80

F 413

5156	3498	358.7	109.35
5158	3494	358.7	109.35
5161	3491	359.9	109.70
5165	3489	356.9	108.80
5169	3487	355.4	108.35

F 414

4885	3230	329.3	100.35
4888	3233	328.4	100.10
4891	3236	326.5	99.50
4892	3240	326.5	99.50
4894	3245	326.3	99.45
4897	3248	326.6	99.55
4899	3252	325.8	99.30
4901	3256	325.3	99.15
4903	3260	324.8	99.00
4905	3264	324.9	99.05
4902	3266	324.1	98.80
4899	3268	322.9	98.40
4896	3269	324.3	98.85
4908	3268	325.1	99.10
4911	3271	324.1	98.80
4913	3274	323.0	98.45
4916	3277	323.2	98.50
4918	3281	322.3	98.25
4920	3285	322.7	98.35
4923	3289	322.2	98.20
4926	3293	321.5	98.00
4929	3297	320.8	97.80
4931	3300	321.1	97.85
4933	3298	322.0	98.15
4928	3302	320.6	97.70
4927	3304	319.6	97.40
4936	3301	321.0	97.85
4938	3305	321.6	98.00
4940	3309	320.8	97.80
4941	3313	319.7	97.45
4943	3317	319.6	97.40
4945	3320	318.8	97.15
4947	3324	318.3	97.00

F 415

5167	3500	367.8	112.10
5171	3502	365.4	111.35
5175	3504	364.6	111.15
5179	3506	363.9	110.90
5178	3510	363.2	110.70
5180	3502	362.7	110.55
5181	3498	362.6	110.50
5182	3495	365.8	111.50
5183	3507	363.2	110.70
5187	3508	364.6	111.15
5191	3510	363.6	110.85

F 417

5184	3482	357.7	109.05

5189	3485	357.2	108.85
5193	3488	358.0	109.10
5193	3493	356.5	108.65
5192	3497	356.7	108.70
5197	3490	356.7	108.70

F 418

4984	3345	315.4	96.15
4988	3346	316.0	96.30
4992	3348	315.7	96.25
4996	3349	316.6	96.50
5000	3351	316.3	96.40
5005	3353	315.0	96.00
5009	3355	315.2	96.05
5012	3357	314.6	95.90
5015	3361	314.1	95.75
5018	3365	311.7	95.00
5020	3369	311.6	95.00

F 420

5053	3445	354.6	108.10
5056	3448	355.4	108.35
5060	3451	355.2	108.25
5063	3454	353.5	107.75
5067	3457	350.8	106.90
5070	3460	348.1	106.10

F 421

5187	3531	323.0	98.45
5192	3531	322.5	98.30
5195	3532	322.5	98.30
5197	3533	320.0	97.55
5200	3535	319.4	97.35
5203	3536	320.2	97.60
5205	3533	319.9	97.50
5209	3537	319.4	97.35
5214	3536	318.6	97.10

F 422

4765	3743	456.0	139.00
4768	3742	454.6	138.55
4771	3741	454.8	138.60
4775	3740	455.5	138.85
4772	3737	454.1	138.40

F 423

5164	3530	305.9	93.25
5166	3534	305.7	93.20
5170	3537	305.3	93.05
5174	3540	304.3	92.75
5178	3543	303.8	92.60
5180	3539	303.3	92.45
5182	3544	302.2	92.10
5187	3544	300.8	91.70
5192	3543	300.0	91.45

F 424

4755	3750	412.9	125.85

F 425

5163	3533	302.6	92.25
5166	3537	301.5	91.90
5169	3540	300.5	91.60
5173	3543	299.7	91.35
5177	3545	298.9	91.10
5183	3546	298.2	90.90
5189	3546	298.0	90.85
5194	3545	298.1	90.85
5199	3543	297.8	90.75
5204	3541	297.6	90.70
5209	3540	296.8	90.45
5214	3539	297.3	90.60
5218	3538	297.2	90.60
5218	3536	296.2	90.30
5222	3536	297.8	90.75
5227	3535	296.6	90.40
5232	3533	295.8	90.15
5237	3532	295.5	90.05
5241	3531	296.8	90.45
5245	3530	296.0	90.20
5249	3529	295.4	90.05
5254	3527	295.2	90.00
5258	3524	295.2	90.00
5262	3520	294.8	89.85
5265	3517	293.6	89.50
5267	3513	292.9	89.30
5269	3508	292.7	89.20

F 427

5212	3526	330.4	100.70
5217	3526	330.8	100.85
5222	3526	330.1	100.60
5226	3519	331.7	101.10
5226	3526	328.3	100.05
5231	3526	329.3	100.35
5236	3527	331.0	100.90
5235	3525	329.6	100.45
5239	3522	330.6	100.75
5243	3520	330.5	100.75
5247	3518	330.9	100.85
5249	3520	329.2	100.35
5246	3516	330.8	100.85
5251	3515	325.6	99.25
5254	3511	324.2	98.80

5258	3508	322.9	98.40

F 428

4977	3551	405.8	123.70
4979	3549	407.0	124.05
4981	3547	406.7	123.95
4983	3545	406.9	124.00
4980	3543	407.0	124.05
4985	3547	408.7	124.55
4988	3549	410.9	125.25
4985	3543	407.9	124.35
4987	3540	409.0	124.65
4989	3537	410.4	125.10
4993	3534	410.0	124.95
4996	3532	410.0	124.95

F 429

5258	3519	299.1	91.15
5260	3515	298.0	90.85
5262	3511	296.2	90.30
5265	3507	293.7	89.50

F 431

5186	3460	351.0	107.00
5191	3460	352.3	107.40
5195	3460	353.4	107.70
5200	3460	353.4	107.70
5205	3461	352.6	107.45
5210	3460	354.0	107.90
5215	3460	354.9	108.15
5220	3460	353.2	107.65
5225	3460	353.2	107.65
5230	3460	353.0	107.60
5234	3460	353.2	107.65
5238	3460	353.0	107.60
5238	3455	351.9	107.25
5242	3462	350.3	106.75
5238	3465	348.5	106.20
5238	3470	350.7	106.90
5238	3475	351.8	107.25
5237	3480	351.8	107.25
5223	3475	353.8	107.85
5228	3475	353.2	107.65
5233	3475	352.9	107.55

F 433

5198	3445	364.3	111.05
5202	3445	363.4	110.75
5207	3445	362.0	110.35
5210	3445	362.7	110.55
5210	3440	363.0	110.65
5215	3445	361.3	110.10

F 435

5261	3478	354.5	108.05
5265	3476	352.9	107.55
5269	3474	352.6	107.45
5273	3472	354.4	108.00
5277	3470	355.2	108.25
5281	3468	355.4	108.35
5285	3467	355.8	108.45
5289	3466	354.5	108.45

F 437

5272	3485	347.8	106.00
5275	3481	348.5	106.20
5279	3477	348.4	106.20
5283	3475	347.4	105.90
5287	3474	347.6	105.95

F 438

5174	3556	375.5	114.45
5179	3557	374.4	114.10
5183	3558	374.7	114.20
5187	3559	376.2	114.65

F 439

5296	3474	347.4	105.90
5300	3474	347.3	105.85
5305	3475	345.9	105.45
5303	3471	344.2	104.90
5307	3469	341.1	103.95
5312	3467	340.1	103.65
5317	3465	338.4	103.15
5321	3464	337.5	102.85
5326	3463	335.8	102.35
5331	3462	334.7	102.00
5336	3462	333.5	101.65

F 440

5189	3562	379.4	115.65
5193	3562	377.9	115.20
5198	3563	377.3	115.00
5202	3563	378.3	115.30
5207	3564	375.3	114.40
5213	3565	379.0	115.50
5213	3560	377.3	115.00
5216	3564	379.1	115.55
5215	3569	379.3	115.60
5221	3565	378.6	115.40

F 442

5213	3580	391.5	119.35
5212	3584	392.8	119.75
5218	3580	390.7	119.10
5223	3580	389.3	118.65
5228	3580	387.3	118.05
5232	3579	391.0	119.20

F 443

5320	3447	335.3	102.20
5317	3445	334.3	101.90
5317	3440	334.2	101.85
5318	3436	335.8	102.35

F 444

5223	3557	368.0	112.15
5228	3557	369.3	112.55
5229	3559	371.9	113.35

F 446

5226	3545	299.0	91.15
5231	3544	298.7	91.05
5236	3543	299.3	91.25
5235	3546	300.7	91.65
5240	3542	299.0	91.15
5244	3540	296.8	90.45
5249	3538	297.1	90.55
5253	3537	297.4	90.65

F 447

5323	3487	292.8	89.25
5325	3482	293.6	89.50
5329	3481	291.8	88.95
5334	3481	290.7	88.60
5338	3480	291.3	88.80
5340	3480	291.8	88.95
5340	3475	288.6	87.95
5345	3480	291.7	88.90
5349	3480	290.9	88.65
5353	3479	290.0	88.40
5358	3478	289.8	88.35
5357	3474	289.5	88.25
5355	3470	287.6	87.65
5361	3472	289.6	88.25
5365	3470	287.9	87.75
5369	3468	287.6	87.65
5373	3466	287.4	87.60
5372	3462	286.3	87.25
5370	3458	287.9	87.75
5369	3455	287.6	87.65
5378	3464	286.5	87.35
5381	3461	286.1	87.20
5384	3458	286.6	87.35
5387	3455	286.5	87.35
5391	3451	286.5	87.35

F 448

5235	3555	302.1	92.10
5238	3555	303.7	92.55
5237	3551	301.7	91.95
5240	3548	301.1	91.80

F 449

5325	3490	288.9	88.05
5328	3491	288.4	87.90
5332	3491	288.0	87.80
5336	3490	287.6	87.65
5341	3489	286.8	87.40
5345	3487	287.0	87.50
5349	3486	287.2	87.55
5353	3484	286.7	87.40
5357	3483	286.4	87.30
5361	3481	286.3	87.25
5365	3479	285.8	87.10
5368	3477	285.9	87.15
5371	3475	285.7	87.10
5370	3473	285.2	86.95
5375	3473	284.8	86.80
5379	3470	284.8	86.80
5382	3468	284.8	86.80
5385	3465	284.6	86.75
5388	3461	284.7	86.80
5391	3458	283.8	86.50
5389	3456	282.2	86.00
5394	3456	282.9	86.25
5397	3453	282.2	86.00
5400	3449	281.5	85.80

F 449b

5400	3447	286.9	87.45
5405	3447	286.6	87.35

F 450

5282	3507	316.5	96.45
5286	3504	316.5	96.45
5291	3502	317.3	96.70
5295	3500	318.5	97.10
5300	3499	319.8	97.50
5305	3499	321.1	97.85
5310	3499	317.1	96.65

F 451

5347	3400	316.7	96.55
5343	3401	315.4	96.15
5338	3401	315.3	96.10
5350	3400	315.0	96.00
5355	3399	314.0	95.70
5360	3399	314.1	95.75
5365	3398	314.9	96.00
5349	3404	313.9	95.70
5348	3409	312.0	95.10
5346	3413	310.8	94.75
5346	3416	308.6	94.05
5348	3420	304.7	92.85
5351	3423	302.9	92.30
5353	3427	300.7	91.65
5355	3431	298.5	91.00
5357	3435	297.4	90.65
5360	3439	296.5	90.35
5362	3442	293.9	89.60
5364	3446	292.8	89.25
5365	3450	291.9	88.95
5366	3453	292.2	89.05
5370	3453	292.0	89.00
5374	3451	290.0	88.40
5378	3451	290.8	88.65
5378	3447	290.0	88.40
5379	3444	289.3	88.20
5380	3440	289.5	88.25
5382	3450	289.3	88.20
5386	3449	288.1	87.80
5390	3448	287.5	87.65
5394	3447	286.6	87.35

F 452

5277	3502	294.5	89.75
5279	3498	293.8	89.55
5282	3494	293.9	89.60
5285	3492	293.6	89.50
5288	3488	291.9	88.95
5292	3485	292.1	89.05
5296	3486	291.4	88.80
5297	3490	292.6	89.20
5301	3487	290.4	88.50
5305	3488	288.4	87.90
5310	3490	289.4	88.20
5314	3492	289.1	88.10
5318	3495	288.1	87.80

F 453

5381	3437	292.6	89.20
5383	3434	292.0	89.00
5384	3431	292.4	89.10
5390	3442	289.5	88.25

F 455

5380	3417	336.1	102.45
5380	3412	337.2	102.80
5381	3407	340.9	103.90
5384	3417	337.0	102.70
5388	3418	337.6	102.90
5392	3419	336.8	102.65
5396	3419	336.6	102.60
5400	3420	336.1	102.45
5401	3415	337.7	102.95
5402	3411	340.5	103.80
5403	3406	342.1	104.25

F 457

5401	3429	321.9	98.10
5406	3427	321.0	97.85
5405	3431	322.3	98.25
5409	3432	322.8	98.40
5413	3432	322.3	98.25

F 458

5323	3503	330.8	100.85
5327	3502	331.0	100.90
5327	3505	328.9	100.25
5334	3500	326.6	99.55

F 459

5443	3419	279.9	85.30
5447	3418	279.6	85.20
5449	3423	277.6	84.60
5450	3428	278.8	85.00
5451	3432	280.8	85.60
5451	3416	279.9	85.30
5449	3412	279.4	85.15
5446	3408	278.8	85.00
5443	3405	277.5	84.60
5455	3414	280.4	85.45
5460	3412	282.1	86.00
5465	3412	283.2	86.30

F 460

5389	3473	285.4	87.00
5392	3471	285.7	87.10
5396	3469	285.1	86.90
5399	3467	284.8	86.80
5401	3465	285.6	87.05
5404	3463	284.6	86.75
5409	3461	284.8	86.80

5413	3461	283.8	86.50
5417	3462	283.3	86.35
5418	3459	282.4	86.10
5419	3456	281.5	85.80
5420	3461	282.3	86.05
5424	3460	281.5	85.80
5427	3459	281.9	85.90
5431	3460	280.1	85.35
5436	3461	280.5	85.50
5441	3462	280.2	85.40
5446	3463	279.5	85.20
5450	3464	279.6	85.20
5452	3466	278.8	85.00
5456	3465	277.8	84.65
5461	3466	277.5	84.60
5465	3467	276.4	84.25
5470	3468	276.5	84.30
5474	3469	277.3	84.50

F 461

5441	3448	281.7	85.85
5445	3447	280.2	85.40
5450	3447	279.8	85.30
5454	3447	280.5	85.50
5454	3451	281.9	85.90
5455	3443	279.4	85.15
5459	3447	279.0	85.05
5464	3447	279.2	85.10
5469	3447	278.2	84.80
5473	3447	277.7	84.65
5478	3447	277.8	84.65
5483	3447	277.4	84.55
5486	3448	277.6	84.60
5485	3453	275.6	84.00
5490	3455	277.2	84.50
5495	3456	277.5	84.60
5499	3458	277.5	84.60
5504	3459	277.9	84.70
5509	3459	277.3	84.50
5514	3459	277.4	84.55
5519	3459	275.4	83.95
5523	3458	274.9	83.80
5528	3458	274.4	83.65
5532	3458	274.7	83.75
5532	3454	274.1	83.55
5532	3450	273.1	83.25
5532	3466	272.1	82.95
5532	3442	273.4	83.35
5532	3438	272.6	83.10
5532	3434	271.5	82.75
5532	3430	272.5	83.05
5532	3425	272.5	83.05
5532	3421	272.1	82.95
5537	3458	274.5	83.65
5541	3459	274.2	83.60
5546	3459	273.2	83.25
5550	3460	273.2	83.25
5554	3460	273.3	83.30
5554	3470	271.4	83.70
5558	3473	272.4	83.05
5563	3475	271.8	82.85
5567	3477	270.6	82.50
5570	3480	270.5	82.45
5573	3483	270.9	82.55
5573	3488	270.8	82.55
5572	3493	271.9	82.90
5574	3479	271.2	82.65
5574	3475	269.6	82.15
5574	3470	269.1	82.00
5575	3466	267.0	81.40
5575	3461	268.8	81.95
5576	3457	268.6	81.85
5576	3453	269.8	82.25
5577	3449	270.1	82.35
5577	3445	270.3	82.40
5577	3440	269.6	82.15
5578	3436	268.6	81.85
5578	3431	268.4	81.80
5579	3426	266.7	81.30
5579	3422	269.1	82.00

F 462

5407	3455	282.5	84.80
5411	3453	283.1	86.30
5416	3452	281.9	85.90
5420	3453	281.5	85.80

F 463

5446	3447	280.7	85.55
5450	3448	280.2	85.40
5454	3449	280.2	85.40

F 464

5405	3475	284.3	86.65
5410	3473	284.4	86.70
5414	3472	284.7	86.80
5418	3470	284.2	86.60
5422	3470	283.4	86.40
5426	3470	284.0	86.55
5431	3470	282.6	86.15
5435	3470	282.1	86.00
5439	3471	281.4	85.75
5444	3471	281.2	85.70
5446	3471	281.9	85.90
5451	3469	281.0	85.65
5456	3470	280.8	85.60

5461	3470	280.4	85.45
5466	3472	279.6	85.20
5471	3473	279.0	85.05

F 465

5442	3453	279.9	85.30
5445	3454	278.6	84.90
5449	3455	277.3	84.50
5453	3457	276.5	85.30
5459	3458	276.9	84.40
5463	3458	276.3	84.20
5467	3458	275.0	83.80

F 466

5410	3485	284.2	86.60
5414	3484	284.3	86.65
5418	3484	286.2	87.25
5424	3484	285.0	86.85
5429	3484	285.5	87.00
5434	3484	285.0	86.85
5438	3484	283.7	86.45
5440	3482	283.7	86.45
5445	3483	282.5	86.10
5449	3485	282.7	86.15
5454	3486	282.2	86.00
5459	3487	281.8	85.90
5464	3487	281.5	85.80
5464	3492	280.0	85.35
5464	3497	279.6	85.20
5465	3482	281.6	85.85
5467	3478	280.4	85.45

F 467

5460	3445	279.0	85.05
5464	3445	278.6	84.90
5468	3446	278.3	84.85

F 468

5469	3509	334.8	102.05
5474	3509	334.6	102.00
5478	3508	332.2	101.25
5482	3508	333.6	101.70
5482	3511	331.9	101.15
5486	3508	333.5	101.65
5490	3508	332.6	101.40

F 470

5481	3469	277.0	84.45
5486	3469	278.0	84.75
5491	3469	278.3	84.85
5496	3469	277.8	84.65
5501	3469	276.3	84.20
5501	3474	274.8	83.75
5505	3469	275.8	84.05
5510	3469	275.4	83.95
5514	3470	275.7	84.05
5514	3468	274.4	83.65
5514	3475	272.7	83.10
5514	3480	273.5	83.35
5514	3485	274.9	83.80
5514	3490	274.9	83.80
5519	3470	274.8	83.75
5524	3471	273.5	83.35
5528	3472	274.0	83.50
5532	3474	273.6	83.40
5536	3476	273.9	83.50
5540	3478	274.5	83.65
5544	3481	272.3	83.00
5547	3485	271.8	82.85
5550	3488	270.9	82.55
5554	3491	270.4	82.40
5557	3495	270.0	82.30
5561	3498	270.2	82.35

F 473

5561	3487	272.4	83.05
5565	3490	273.0	83.20
5570	3492	272.2	82.95
5574	3494	271.7	82.80
5579	3494	271.2	82.65
5583	3493	270.7	82.50
5588	3491	270.4	82.40
5592	3489	270.0	82.30
5597	3487	269.2	82.05
5601	3485	268.6	81.85
5605	3482	267.3	81.45
5609	3478	266.9	81.35
5612	3475	266.5	81.25
5615	3471	266.2	81.15
5619	3468	265.7	81.00
5619	3464	267.8	81.65
5622	3459	266.0	81.10
5625	3456	266.0	81.10

F 475

5590	3493	273.9	83.50
5596	3472	272.9	83.20
5598	3468	272.0	82.90
5600	3463	271.4	82.70
5602	3459	271.5	82.75
5605	3455	272.2	82.95

F 476

5267	3477	265.8	81.00
5631	3475	264.8	80.70
5635	3471	264.5	80.60
5638	3468	264.0	80.45
5642	3466	263.6	80.35
5646	3464	263.2	80.20
5650	3461	263.1	80.20
5654	3459	262.7	80.05
5659	3458	261.9	79.85
5664	3459	262.0	79.85
5666	3461	261.8	79.80
5670	3465	260.7	79.45
5674	3469	259.6	79.15

F 477

5592	3454	278.8	85.00
5597	3454	279.2	85.10
5601	3455	275.6	84.00

F 479

5623	3444	293.3	89.40
5621	3440	293.4	89.45
5624	3441	295.7	90.15

F 480

5783	3467	259.0	78.95
5783	3462	257.9	78.60
5783	3458	257.7	78.55
5784	3453	256.1	78.05

F 481

5631	3450	266.0	81.10
5634	3447	267.4	81.50
5632	3443	266.6	81.25
5630	3440	265.9	81.05
5637	3445	266.3	81.15
5641	3442	265.3	80.85

F 482

5792	3445	266.4	81.20
5794	3441	264.1	80.50
5797	3437	263.0	80.15
5800	3434	262.0	79.85
5802	3431	261.4	79.65

F 483

5778	3463	261.9	79.85
5782	3464	261.2	79.60
5785	3466	260.5	79.40
5789	3467	260.2	79.30
5792	3469	259.7	79.15
5795	3471	258.7	78.85
5799	3472	258.7	78.85
5803	3472	257.8	78.60
5806	3473	257.8	78.60

F 484

5803	3429	255.6	77.90
5805	3425	255.1	77.75
5808	3423	255.3	77.80
5811	3421	254.7	77.65
5814	3418	254.7	77.65
5817	3416	254.1	77.45
5820	3414	253.0	77.10

F 485

5814	3474	265.0	80.75
5819	3474	264.6	80.65
5823	3474	263.3	80.25
5823	3472	263.5	80.30
5827	3473	262.7	80.05
5832	3473	262.5	80.00
5836	3472	262.6	80.05

F 486

5846	3300	237.0	72.25
5845	3297	237.1	72.25
5845	3293	237.4	72.35
5845	3289	237.6	72.40
5844	3285	235.5	71.80
5844	3281	235.8	71.85
5844	3277	234.9	71.60

F 487

5863	3459	261.4	79.65
5866	3456	261.2	79.60
5869	3452	261.7	79.75
5871	3449	262.0	79.85
5874	3446	261.7	79.75
5877	3443	261.0	79.55
5880	3440	261.2	79.60
5877	3438	258.8	78.90
5883	3437	260.2	79.30
5886	3434	257.8	78.60
5889	3431	257.4	78.45

F 488

5848	3297	242.0	73.75
5848	3292	242.5	73.90
5849	3287	242.8	74.00
5850	3282	242.6	73.95
5851	3277	242.1	73.80
5852	3272	241.6	73.65

5853	3267	241.9	73.75
5855	3262	241.2	73.50
5856	3257	241.2	73.50
5857	3252	240.6	73.35
5858	3248	240.3	73.25
5860	3244	240.2	73.20
5862	3240	240.2	73.20
5865	3243	238.5	72.70
5868	3245	237.6	72.40
5872	3247	237.1	72.25
5875	3249	236.6	72.10
5878	3251	236.8	72.20
5881	3253	238.3	72.65
5885	3255	236.7	72.15
5889	3257	235.6	71.80
5859	3238	239.7	73.05
5856	3236	238.6	72.75
5850	3232	238.1	72.55
5852	3229	236.3	72.00
5855	3226	236.7	72.15
5857	3223	235.6	71.80
5883	3249	236.9	72.20
5885	3245	236.4	72.05
5886	3241	236.5	72.10
5887	3237	236.2	72.00
5888	3233	234.4	71.45
5888	3229	235.2	71.70
5889	3226	234.9	71.60

<u>F 490</u>

5859	3286	255.9	78.00
5861	3283	256.7	78.25
5864	3281	255.9	78.00
5867	3279	256.0	78.05
5870	3278	256.7	78.25
5872	3278	256.4	78.15
5875	3279	256.9	78.30
5878	3281	258.8	78.90
5876	3277	254.3	77.50
5880	3277	253.9	77.40

<u>F 492</u>

5855	3213	232.9	71.00
5859	3213	232.5	70.85
5864	3213	232.3	70.80
5868	3212	232.3	70.80
5872	3213	232.2	70.75
5876	3214	231.7	70.60
5881	3215	231.6	70.60
5885	3216	231.4	70.55

<u>F 494</u>

5889	3213	227.5	69.35
5893	3213	228.5	69.65
5897	3212	228.2	69.55

<u>F 496</u>

5898	3160	223.1L	68.00
5897	3156	223.0L	67.95
5896	3152	223.9L	68.25
5894	3148	223.8L	68.20
5893	3145	223.2L	68.05
5893	3141	224.2L	68.35

<u>F 497</u>

5887	3203	232.3	70.80
5891	3200	229.7	70.00
5892	3196	230.3	70.20
5892	3191	230.2	70.15
5891	3187	229.3	69.90
5890	3182	229.5	69.95
5893	3181	227.7	69.40
5887	3183	228.5	69.65
5885	3183	229.8	70.05
5888	3178	227.2	69.25
5886	3175	226.8	69.15
5885	3171	227.2	69.25
5883	3167	227.5	69.35
5881	3164	226.6	69.05
5880	3160	224.8	68.50

<u>F 498</u>

5902	3155	224.8L	68.50
5902	3151	225.0L	68.60
5902	3147	224.5L	68.45
5902	3143	224.4L	68.40
5906	3143	223.1L	68.00
5909	3143	222.7L	67.90
5902	3139	222.7L	67.90
5902	3135	222.8L	67.90
5903	3132	223.9L	68.25

<u>F 500</u>

5903	3169	230.0L	70.10
5904	3166	230.7L	70.30
5906	3162	231.7L	70.60
5908	3158	230.7L	70.30
5910	3154	229.7L	70.00
5911	3150	228.9L	69.75

5912	3148	227.5L	69.35
5914	3152	227.6L	69.35
5915	3155	227.2L	69.25
5916	3158	228.3L	69.60
5916	3149	227.9L	69.45
5920	3150	226.3L	69.00
5925	3150	225.7L	68.80
5929	3150	225.2L	68.65

F 501

5885	3162	224.4	68.40
5884	3158	224.7	68.50
5883	3154	222.7	67.90
5881	3154	223.7	68.20
5882	3150	223.0	67.95
5882	3146	221.4	67.50

F 502

5911	3137	228.1L	69.50
5914	3138	227.9L	69.45
5916	3134	226.5L	69.05
5917	3130	224.9L	68.55
5919	3127	223.1L	68.00
5918	3139	227.3L	69.30
5922	3140	226.6L	69.05

F 503

5950	3155	216.8	66.10
5952	3159	216.8	66.10
5953	3163	216.0	65.85
5955	3167	216.1	65.85
5956	3170	216.6	66.00
5960	3172	217.6	66.30
5963	3174	217.3	66.25
5967	3176	217.6	66.30
5970	3178	216.1	65.85
5974	3180	215.2	65.60
5977	3182	214.8	65.45
5980	3185	214.6	65.40
5983	3188	212.8	64.85
5986	3190	214.9	65.50
5989	3193	214.1	65.25
5992	3195	213.8	65.15
5995	3198	213.0	64.90
5998	3201	212.9	64.90
6001	3204	211.3	64.40
6004	3207	212.3	64.70
6007	3209	212.3	64.70
6009	3207	210.7	64.20
6010	3212	212.3	64.70
6013	3215	211.9	64.60
6017	3217	211.3	64.40
6021	3219	211.0	64.30

F 504

5921	3123	222.2L	67.75
5925	3124	221.1L	67.40
5928	3126	221.0L	67.35
5930	3130	220.2L	67.10
5932	3134	219.0L	66.75
5933	3137	218.9L	66.70
5933	3142	218.4L	66.55
5934	3146	218.2L	66.50
5936	3150	218.1L	66.50
5938	3155	217.3L	66.25
5940	3158	217.0L	66.15
5941	3162	216.4L	65.95

F 505

5965	3162	221.5	67.50
5968	3165	221.8	67.60
5971	3167	220.6	67.24
5975	3170	219.9	67.05
5978	3173	219.5	66.90
5981	3176	218.4	66.55

F 506

5920	3163	230.9L	70.40
5922	3162	229.1L	69.85
5926	3160	227.8L	69.45
5930	3160	228.1L	69.50
5934	3161	226.4L	69.00
5938	3162	225.0L	68.60

F 507

5984	3179	220.2	67.10
5987	3182	221.1	67.40
5990	3185	221.9	67.65
5993	3188	222.2	67.75
5996	3190	222.4	67.80
5999	3193	222.8	67.90
6002	3195	222.1	67.70

F 508

5929	3166	240.6	73.35
5934	3167	240.2	73.20
5938	3168	240.0	73.15
5942	3169	239.7	73.05

F 509

5993	3180	225.1	68.60

5996	3183	224.5	68.45
6000	3185	224.1	68.30
6003	3188	222.7	67.90
6006	3191	222.7	67.90
6010	3194	222.4	67.80
6013	3197	221.6	67.55
6016	3200	220.1	67.10

F 510

5930	3183	252.6	77.00
5934	3184	251.9	76.80
5938	3186	251.7	76.70
5943	3187	249.9	76.15
5941	3190	249.7	76.10
5940	3194	251.6	76.70
5947	3189	248.8	75.85
5951	3190	247.4	75.40
5955	3192	246.0	75.00
5959	3194	244.0	74.35
5963	3196	242.7	73.95
5966	3198	242.6	73.95

F 511

6013	3203	216.6	66.00
6016	3206	216.3	65.95
6020	3209	216.4	65.95
6024	3212	215.8	65.80
6026	3215	216.0	65.85
6028	3211	215.4	65.65
6030	3207	214.0	65.25
6030	3218	214.6	65.40
6034	3219	214.2	65.30
6039	3220	214.1	65.25
6043	3220	213.5	65.05
6047	3220	213.0	64.90
6051	3220	212.6	64.80

F 512

5977	3196	218.3L	66.55
5980	3199	215.4L	65.65
5983	3202	214.5L	65.40
5986	3206	214.3L	65.30
5990	3209	214.8L	65.45
5993	3212	214.6L	65.40
5997	3215	213.9L	65.20
6000	3218	214.6L	65.40
5999	3221	214.0L	65.25
5997	3224	212.2L	64.70
6004	3220	213.2L	65.00
6008	3223	212.6L	64.80
6012	3225	212.2L	64.70
6016	3227	211.1L	64.35

6020	3230	209.9L	64.00
6025	3232	209.9L	64.00
6029	3235	209.0L	63.70
6033	3237	208.7L	63.60
6037	3240	208.7L	63.60
6041	3240	208.3L	63.50
6045	3245	207.9L	63.35

F 513

6046	3232	211.2	64.35
6050	3233	211.2	64.35
6055	3233	211.1	64.35
6059	3231	210.7	64.20
6062	3228	210.3	64.10
6066	3225	210.0	64.00
6070	3222	209.1	63.75
6073	3219	208.2	63.45
6076	3222	206.9	63.05
6080	3219	206.2	62.85
6083	3215	205.9	62.75
6086	3212	205.8	62.75
6090	3209	204.7	62.40
6093	3205	204.1	62.20

F 514

6093	3221	205.8	62.75
6096	3218	205.6	62.65
6099	3215	205.7	62.70
6102	3211	205.2	62.55
6105	3207	205.8	62.75
6108	3202	205.9	62.75
6110	3198	203.5	62.05
6111	3193	203.9	62.15
6112	3188	202.6	61.75
6113	3183	203.4	62.00
6114	3178	203.1	61.90
6115	3173	202.5	61.70

F 516

6088	3134	200.5	61.10
6083	3132	200.4	61.10
6080	3130	200.5	61.10
6077	3127	202.6	61.75
6074	3123	202.7	61.80
6072	3120	202.7	61.80
6070	3116	201.4	61.40
6074	3115	200.5	61.10
6066	3117	198.2	60.40
6069	3112	201.1	61.30
6069	3108	200.1	61.00
6068	3103	198.9	60.60
6069	3099	197.7	60.25

6069	3094	196.6	59.90

F 517

6058	3214	216.4	65.95
6063	3213	215.2	65.60
6068	3212	213.5	65.05
6073	3210	212.8	64.85
6077	3207	213.3	65.00
6080	3204	212.9	64.90
6083	3201	212.4	64.75
6087	3198	211.8	64.55
6084	3194	211.9	64.60
6081	3189	210.5	64.15
6078	3185	208.7	63.60
6088	3195	210.0	64.00
6090	3190	209.2	63.75
6090	3186	210.0	64.00
6091	3181	209.8	63.95
6092	3176	208.5	63.55
6092	3172	207.3	63.20
6092	3167	207.3	63.20
6091	3163	208.0	63.40
6087	3159	206.9	63.05
6083	3157	205.5	62.65
6081	3156	205.2	62.55

F 519

6065	3198	224.8	68.50
6067	3194	224.1	68.30
6070	3191	223.5	68.10
6066	3190	222.6	67.85
6072	3188	222.8	67.90
6074	3184	221.7	67.55

F 520

6089	3114	203.7	62.10
6087	3110	202.6	61.75
6085	3106	202.6	61.75
6084	3101	202.7	61.80
6082	3097	203.1	61.90
6081	3092	203.1	61.90
6082	3087	202.4	61.70
6083	3083	202.2	61.65
6085	3079	201.2	61.35
6087	3075	200.9	61.25
6090	3078	200.4	61.10
6094	3080	199.0	60.65
6090	3072	200.7	61.15
6093	3069	199.5	60.80
6097	3067	198.6	60.55
6101	3065	197.8	60.30
6105	3064	197.1	60.10
6110	3063	197.5	60.20

F 521

6054	3197	230.9	70.40
6056	3193	229.6	70.00
6058	3189	229.8	70.05
6061	3185	229.7	70.00
6063	3182	229.7	70.00
6060	3180	230.4	70.25
6065	3178	230.1	70.15
6067	3175	230.0	70.10
6069	3171	230.1	70.15
6070	3167	229.3	69.90
6068	3164	228.9	69.75

F 522

6102	3108	244.3	74.45
6100	3111	245.0	74.70
6100	3116	245.3	74.75
6105	3104	244.3	74.45
6107	3100	243.6	74.25
6105	3110	243.3	74.15
6109	3112	242.8	74.00
6112	3115	243.2	74.15
6116	3118	242.4	73.90
6120	3120	241.0	73.45
6123	3123	238.0	72.55
6127	3125	240.3	73.25

F 523

6058	3175	234.1	71.35
6060	3171	233.7	71.25
6062	3167	233.0	71.00

F 524

6108	3087	238.0	72.55
6113	3087	237.5	72.40
6117	3088	231.6	70.60
6122	3090	230.1	70.15
6126	3092	229.8	70.05
6130	3096	229.4	69.90
6132	3093	228.5	69.65
6128	3099	227.1	69.20
6134	3098	227.7	69.40
6137	3102	225.8	68.80
6140	3105	225.2	68.65
6143	3108	224.3	68.35
6146	3112	224.5	68.45
6148	3115	224.6	68.45
6145	3117	224.3	68.35
6150	3118	223.5	68.10
6152	3122	223.2	68.05
6153	3126	223.4	68.10

F 525

6045	3188	246.3	75.05
6047	3184	244.0	74.35
6049	3180	241.7	73.65

F 526

6104	3083	215.0	65.55
6105	3079	215.5	65.70
6107	3075	214.6	65.40
6110	3072	214.3	65.30
6112	3068	214.0	65.25
6116	3068	211.5	64.45
6120	3070	211.3	64.40
6124	3072	212.0	64.60
6127	3074	211.4	64.45
6131	3076	211.0	64.30

F 527

6041	3187	249.9	76.15
6043	3183	250.3	76.30
6045	3179	249.4	76.00
6047	3175	249.5	76.05
6049	3171	249.3	76.00
6045	3169	248.3	75.70
6051	3167	248.2	75.65
6053	3163	245.5	74.85
6050	3161	244.6	74.55
6047	3159	248.8	75.85

F 528

6119	3078	217.0	66.15
6122	3080	216.0	65.85
6121	3082	216.5	66.00
6124	3078	215.7	65.75
6126	3082	214.5	65.40
6130	3084	212.7	64.85

F 529

6021	3187	260.9	79.50
6020	3182	260.9	79.50
6017	3178	258.5	78.80
6014	3174	256.2	78.10
6025		258.8	78.90
6028		257.7	78.55
6032		254.1	77.45
6035		252.2	76.85
6038		252.3	76.90

F 530

6095	3063	195.9	59.70
6099	3061	195.4	59.55
6102	3060	194.7	59.35
6106	3059	194.3	59.20
6111	3058	194.6	59.30
6116	3057	194.1	59.15
6121	3056	193.4	58.95
6126	3056	193.2	58.90
6131	3057	193.1	58.85
6136	3058	193.2	58.90
6134	3062	194.2	59.20
6132	3067	193.6	59.00
6129	3071	192.5	58.65
6139	3065	193.9	59.10
6143	3067	193.3	58.90
6147	3069	193.0	58.85
6150	3072	192.6	58.70
6153	3075	191.9	58.50
6155	3078	191.9	58.50
6158	3082	191.4	58.35
6159	3087	190.2	57.95
6158	3093	190.0	57.90

F 531

6099	3195	210.0	64.00
6101	3190	209.6	63.90
6101	3185	208.9	63.65
6101	3180	208.4	63.50

F 532

6134	3087	215.4	65.65
6138	3089	214.3	65.30
6142	3091	213.6	65.10
6146	3093	213.0	64.90

F 533

6060	3124	202.5	61.70
6063	3127	202.2	61.65
6066	3130	201.8	61.50
6069	3133	201.9	61.55
6072	3136	201.9	61.55
6076	3139	203.1	61.90
6079	3141	202.8	61.80
6083	3143	201.9	61.55
6087	3145	201.2	61.35
6090	3148	200.8	61.20
6093	3151	201.1	61.30
6096	3154	200.3	61.05
6099	3157	199.5	60.80
6101	3161	199.1	60.70
6102	3165	199.2	60.70
6100	3166	199.3	60.75
6102	3170	198.2	60.40
6103	3174	199.3	60.75

6104	3179	198.9	60.60
6103	3183	197.5	60.20

F 534

6142	3081	202.3	61.65
6147	3082	201.9	61.55
6152	3085	199.3	60.75
6155	3089	196.5	59.90
6156	3093	195.2	59.50

F 535

6035	3150	261.8	79.80
6038	3146	258.6	78.80
6040	3142	258.5	78.80
6042	3139	258.2	78.70
6045	3140	258.9	78.90
6039	3137	258.1	78.65
6035	3135	358.3	78.75
6031	3133	256.8	78.25
6028	3131	254.3	77.50
6025	3129	252.8	77.05
6022	3126	252.9	77.10
6018	3124	249.4	76.00
6015	3122	252.6	77.00
6012	3120	255.3	77.80
6043	3135	257.0	78.35
6045	3132	256.3	78.10
6045	3130	256.2	78.10

F 536

6194	3167	182.6	55.65
6198	3170	183.9	56.05
6202	3171	183.9	56.05
6207	3171	183.5	55.95
6212	3171	183.3	55.85
6217	3170	182.7	55.70
6222	3170	182.0	55.45
6226	3169	182.8	55.70

F 537

6067	3076	194.7	59.35
6069	3072	195.4	59.55
6072	3069	196.3	59.85
6075	3066	196.3	59.85
6078	3063	196.1	59.75
6081	3060	195.9	59.70
6084	3062	193.9	59.10
6078	3057	195.8	59.70
6084	3057	195.5	59.60
6087	3055	194.8	59.40
6090	3053	194.2	59.20

6094	3052	193.5	59.00
6099	3051	193.4	58.95

F 538

6235	3170	183.0	55.80
6240	3169	182.8	55.70
6245	3168	181.8	55.40
6250	3167	182.2	55.55
6254	3167	182.1	55.50
6258	3167	182.6	55.65
6262	3167	182.6	55.65
6262	3171	181.8	55.40
6262	3164	182.4	55.60
6266	3167	182.4	55.60
6270	3166	180.9	55.15
6274	3165	181.3	55.25
6278	3164	181.4	55.30

F 541

6168	3097	187.0	57.00
6168	3101	187.9	57.25
6167	3106	187.4	57.10
6166	3110	186.7	56.90
6166	3115	186.8	56.95
6166	3120	185.2	56.45
6165	3125	187.3	57.10
6166	3129	187.8	57.25
6168	3133	188.1	57.35
6169	3137	187.3	57.10
6170	3140	187.5	57.15
6175	3138	185.1	56.40
6173	3145	185.5	56.55
6177	3147	184.7	56.30
6181	3149	183.2	55.85

F 542

6279	3163	183.8	56.00
6283	3161	185.1	56.40
6288	3159	183.1	55.80

F 543

6171	3112	195.9	59.70
6172	3116	194.5	59.30
6173	3120	195.7	59.65
6174	3123	195.2	59.50
6175	3127	193.7	59.05
6176	3130	193.3	58.90
6178	3133	193.3	58.90
6179	3137	193.0	58.85
6180	3140	192.8	58.75
6182	3143	192.9	58.80

6184	3147	192.8	58.75
6186	3150	192.5	58.65
6190	3148	191.6	58.40
6193	3146	190.3	58.00
6188	3152	191.9	58.50
6190	3155	191.0	58.20
6193	3157	190.7	58.15
6196	3159	190.8	58.15
6200	3160	190.3	58.00
6203	3160	190.2	57.95
6206	3161	189.8	57.85
6210	3161	189.4	57.75
6214	3162	188.1	57.35
6218	3162	185.6	56.55
6222	3161	185.2	56.45
6226	3160	186.3	56.80

F 544

6293	3159	184.1	56.10
6298	3158	182.7	55.70
6302	3157	182.0	55.45
6306	3156	180.9	55.15

F 545

6184	3125	193.5	59.00
6187	3128	193.2	58.90
6190	3131	195.7	59.50
6193	3134	195.7	59.65
6195	3135	192.8	58.75
6198	3138	193.3	58.90
6200	3142	192.5	58.65

F 546

6310	3153	177.8	54.20
6314	3152	177.1	54.00
6318	3151	177.7	54.15
6322	3150	178.1	54.30
6326	3149	178.2	54.30
6330	3147	178.4	54.40

F 548

6328	3153	179.6	54.75
6333	3151	179.4	54.70
6338	3150	180.4	55.00
6343	3150	180.5	55.00
6343	3153	178.7	54.45
6349	3151	179.9	54.85
6354	3151	179.4	54.70
6359	3152	178.8	54.50
6364	3153	178.0	54.25

F 549

6200	3122	233.1	71.05
6202	3126	231.5	70.55
6205	3129	231.7	70.55
6207	3132	232.5	70.85
6210	3128	233.1	71.05

F 550

6335	3146	175.4	53.45
6340	3145	175.8	53.60
6345	3144	175.7	53.55
6350	3143	176.2	53.70
6354	3143	176.1	53.70
6358	3143	176.5	53.80
6363	3144	176.9	53.90
6368	3145	176.9	53.90
6372	3147	176.2	53.70
6371	3151	174.9	53.30
6376	3149	175.6	53.50
6381	3152	175.4	53.45
6385	3155	174.7	53.25
6389	3158	174.3	53.15
6392	3161	173.4	52.85

F 551

6205	3146	198.1	60.40
6209	3149	197.9	60.30
6213	3151	197.6	60.25
6216	3153	197.0	60.05
6219	3155	195.9	59.70
6223	3156	197.8	60.30
6227	3157	198.0	60.35

F 552

6364	3158	188.5	57.45
6368	3158	188.5	57.45
6373	3159	188.8	57.55
6377	3160	187.7	57.20
6376	3164	188.3	57.40
6382	3162	187.2	57.05
6386	3165	186.4	56.80
6389	3168	186.3	56.80
6393	3169	186.6	56.90
6398	3171	187.4	57.10

F 553

6237	3110	258.0	78.65
6241	3112	257.9	78.60
6245	3113	257.8	78.60

6248	3115	258.1	78.65

F 554

6400	3164	180.5	55.00
6403	3166	180.1	54.90
6407	3168	179.3	54.65
6411	3170	179.4	54.70
6410	3174	179.1	54.60
6416	3172	178.6	54.45
6420	3174	178.5	54.40
6424	3176	177.9	54.20
6429	3178	177.2	54.00
6433	3180	176.9	53.90
6437	3182	176.4	53.75
6440	3184	175.7	53.55
6445	3187	176.6	53.85
6448	3190	173.9	53.00
6451	3192	173.7	52.95
6454	3195	173.5	52.90

F 555

6243	3131	225.6	68.75
6248	3131	224.8	68.50
6249	3127	225.8	68.80
6253	3132	225.1	68.60
6257	3132	225.2	68.65
6262	3132	223.1	68.00
6272	3131	219.2	66.80
6276	3133	219.3	66.85
6282	3135	217.9	66.40
6286	3137	218.8	66.70

F 556

6449	3187	169.1	51.55
6453	3189	169.3	51.60
6458	3191	170.6	52.00
6462	3191	170.7	52.05
6467	3192	170.3	51.90
6473	3194	169.5	51.65
6478	3194	167.7	51.10
6483	3195	168.5	51.35
6488	3196	168.7	51.40
6494	3196	168.0	51.20

F 559

6231	3160	181.7	55.40
6235	3158	181.2	55.25
6239	3157	180.7	55.10
6243	3155	180.4	55.00
6247	3153	180.9	55.15
6246	3149	180.5	55.00
6251	3151	181.4	55.30
6255	3149	180.8	55.10

F 565

6394	3148	177.7	54.15
6399	3150	177.3	54.05
6402	3152	176.1	53.70
6406	3154	175.5	53.50
6410	3156	172.9	52.70
6414	3158	174.2	53.10
6416	3155	172.1	52.45
6418	3160	173.2	52.80
6422	3162	173.4	52.85
6426	3164	172.4	52.55
6430	3166	172.3	52.50
6434	3169	172.4	52.55
6438	3171	171.6	52.30
6442	3174	171.3	52.20
6446	3176	170.4	51.95
6450	3178	170.0	51.80
6454	3179	169.3	51.60
6458	3181	169.0	51.50
6462	3182	168.8	51.45
6466	3183	168.3	51.30

F 571

6437	3161	215.5	65.70
6450	3166	214.9	65.50
6454	3168	214.3	65.30
6455	3162	214.9	65.50
6456	3158	213.8	65.15
6457	3154	211.6	64.50
6458	3150	212.3	64.70
6460	3146	212.7	64.85
6461	3142	212.3	64.70
6462	3138	211.9	64.60
6463	3134	209.5	63.85
6464	3129	206.6	63.00
6465	3124	210.8	64.25
6466	3121	215.1	65.55
6456	3167	214.3	65.30
6461	3166	212.4	64.75
6466	3165	211.4	64.45
6470	3165	210.5	64.15
6474	3165	208.9	63.65
6478	3164	207.5	63.25
6480	3160	206.8	63.05
6483	3164	207.8	63.35
6486	3165	207.7	63.30
6490	3164	207.5	63.25
6486	3168	198.8	60.60
6490	3167	199.4	60.80
6494	3165	199.5	60.80
6498	3163	199.4	60.80
6502	3161	199.2	60.70
6506	3147	200.6	61.15

6507	3143	198.8	60.60
6508	3139	198.9	60.60
6509	3135	200.6	61.15
6510	3130	201.6	61.45
6511	3126	203.2	61.95
6512	3136	200.4	61.10
6516	3137	201.1	61.30
6520	3138	197.6	60.25
6524	3140	197.3	60.15
6528	3142	197.0	60.05
6532	3141	199.7	60.85
6536	3141	198.7	60.55
6540	3141	197.2	60.10
6544	3140	191.7	58.45
6548	3139	189.8	57.85
6552	3138	192.3	58.60
6555	3135	193.3	58.90
6559	3133	194.2	59.20

F 573

6453	3175	182.9	55.75
6458	3176	182.3	55.55
6462	3178	180.3	54.95

F 574

6776	3193	178.4	54.40
6780	3196	178.4	54.40
6778	3199	175.9	53.60
6776	3202	174.7	53.25
6775	3206	174.9	53.30
6783	3199	176.5	53.80

F 575

6466	3180	176.3	53.75
6471	3181	176.6	53.85
6475	3182	176.3	53.75
6479	3183	175.8	53.60
6483	3183	175.3	53.45
6487	3184	174.4	53.15
6492	3184	173.1	52.75
6496	3184	173.2	52.80
6498	3180	171.1	52.15
6501	3182	170.1	51.85
6504	3179	170.0	51.80
6508	3177	169.4	51.65
6511	3174	169.1	51.55
6515	3172	169.0	51.50
6519	3170	169.1	51.55
6522	3167	168.9	51.50
6525	3165	168.2	51.25
6523	3161	167.5	51.05
6529	3163	168.2	51.25
6532	3160	166.7	50.80
6536	3158	166.2	50.65
6541	3157	166.4	50.70
6545	3155	166.8	50.85
6549	3153	165.8	50.55
6552	3150	165.4	50.40
6555	3148	165.3	50.40
6559	3146	164.7	50.20
6562	3144	164.1	50.00
6566	3141	163.6	49.85
6570	3139	164.0	50.00
6573	3136	163.7	49.90
6576	3134	165.1	50.30
6580	3132	165.5	50.45
6583	3129	165.0	50.30
6587	3127	163.0	49.70

F 576

6771	3183	156.1	47.60
6775	3185	156.0	47.55
6779	3187	156.6	47.75
6782	3190	157.4	48.00
6784	3193	157.1	47.90

F 577

6581	3125	169.1	51.55
6585	3123	168.8	51.45
6588	3121	167.5	51.05
6592	3118	166.5	50.75
6595	3116	166.1	50.65
6599	3114	166.3	50.70
6602	3112	165.4	50.40
6606	3110	164.6	50.15
6610	3108	163.3	49.75

F 578

6791	3197	157.3	47.95
6794	3199	156.9	47.80
6798	3201	156.4	47.65
6802	3203	155.9	47.50
6805	3205	154.8	47.20
6808	3207	155.2	47.30
6812	3209	155.3	47.35
6816	3211	155.4	47.35
6814	3214	153.5	46.80
6812	3217	152.4	46.45
6820	3213	153.9	46.90
6823	3216	152.9	46.60
6826	3219	152.2	46.40
6829	3222	151.8	46.25
6831	3226	150.5	45.85
6833	3230	149.5	45.55

6836	3233	149.2	45.50
6838	3236	148.2	45.15
6840	3240	148.6	45.30
6841	3244	148.5	45.25
6842	3248	147.7	45.00
6842	3252	148.3	45.20

F 580

6909	3341	145.4	44.30
6913	3344	144.8	44.15
6917	3347	144.5	44.05
6921	3350	143.9	43.85
6924	3353	143.6	43.75
6929	3356	143.5	43.75
6933	3358	143.1	43.60
6937	3361	142.7	43.50

F 581

6717	3134	193.2	58.90
6720	3129	192.6	58.70
6724	3125	193.1	58.85
6720	3137	192.8	58.75
6723	3140	190.7	58.15
6728	3126	191.9	58.50
6732	3127	190.7	58.15
6736	3128	189.8	57.85
6740	3130	189.3	57.70

F 582

7008	3357	154.3	47.05
7011	3360	153.0	46.65
7015	3363	152.2	46.40
7019	3366	152.9	46.60
7024	3368	153.2	46.70
7029	3370	152.5	46.50
7035	3371	152.3	46.40
7040	3372	151.4	46.15
7038	3375	152.1	46.35
7035	3377	155.4	47.35
7033	3379	159.2	48.50
7045	3370	150.9	46.00
7050	3373	150.5	45.85
7053	3377	150.3	45.80
7057	3380	149.3	45.50
7062	3382	147.8	45.05
7066	3384	147.5	44.95
7069	3386	147.0	44.80
7073	3388	147.1	44.85
7077	3390	148.3	45.20
7080	3393	146.8	44.75
7084	3396	146.7	44.70
7085	3399	146.2	44.55
7085	3404	146.7	44.70
7083	3407	146.7	44.70
7080	3411	146.1	44.55
7076	3414	146.4	44.60
7073	3417	144.8	44.15
7084	3405	146.2	44.55
7082	3408	145.9	44.45
7083	3412	144.8	44.15
7083	3416	144.3	44.00
7084	3420	146.6	44.70
7083	3421	145.4	44.30
7081	3421	144.8	44.15
7080	3422	143.8	43.85
7078	3423	144.9	44.15
7085	3419	146.6	44.70
7086	3418	145.8	44.45
7087	3418	144.5	44.05
7086	3424	145.1	44.25
7084	3424	143.3	43.70
7088	3427	143.3	43.70
7092	3430	144.0	43.90
7096	3434	142.8	43.55
7099	3437	142.7	43.50
7101	3440	142.0	43.30
7104	3443	142.0	43.30
7107	3447	143.0	43.60
7111	3450	140.9	42.95
7115	3452	141.0	43.00
7119	3453	141.8	43.20
7123	3456	141.0	43.00
7127	3458	141.3	43.05
7131	3460	141.9	43.25
7135	3461	142.0	43.30
7140	3463	142.3	43.35
7140	3464	142.0	43.30
7139	3465	141.6	43.15
7139	3467	141.5	43.15
7138	3468	140.9	42.95
7137	3469	140.3	42.75
7142	3464	142.0	43.30
7147	3466	140.6	42.85
7151	3468	139.4	42.50
7155	3470	138.0	42.05
7158	3471	138.9	42.35
7163	3471	138.3	42.15
7167	3469	139.6	42.55
7171	3467	141.2	43.05
7175	3468	141.1	43.00
7180	3469	140.4	42.80
7184	3470	140.2	42.75
7188	3470	138.5	42.20
7192	3468	136.9	41.75
7196	3465	135.9	41.40
7199	3462	136.6	41.65
7202	3459	137.4	41.90

7205	3456	138.2	42.10
7208	3453	138.2	42.10
7211	3450	137.7	41.95
7213	3452	138.7	42.30
7217	3448	139.3	42.45
7221	3445	140.0	42.65

F 583

6792	3182	145.8	44.45
6795	3184	145.3	44.30
6798	3187	145.2	44.25
6802	3190	144.9	44.15
6804	3186	147.5	44.95
6807	3189	147.8	45.05
6811	3191	147.7	45.00
6815	3193	147.5	44.95
6818	3196	147.8	45.05
6822	3199	147.9	45.10
6825	3201	147.7	45.00
6829	3203	147.1	44.85
6832	3206	144.5	44.05

F 584

7012	3357	135.3	41.25
7o17	3357	135.4	41.25
7022	3357	135.1	41.20
7025	3357	134.1	40.85
7030	3357	133.2	40.60
7034	3357	134.9	41.10
7038	3357	134.9	41.10
7043	3357	134.5	41.00
7047	3357	133.0	40.55
7052	3357	133.4	40.65
7057	3357	134.1	40.85
7060	3356	134.5	41.00
7058	3359	134.2	40.90
7056	3361	133.2	40.60
7054	3364	132.9	40.50
7052	3367	133.5	40.70
7065	3355	133.9	40.80
7070	3355	134.5	41.00
7074	3357	132.3	40.35
7077	3359	133.1	40.55
7078	3363	133.4	40.65
7079	3367	132.7	40.45
7080	3372	132.7	40.45
7081	3376	131.7	40.15
7082	3380	130.7	39.85
7083	3385	128.4	39.15

F 585

6858	3252	147.0	44.80
6860	3255	146.7	44.70
6863	3258	147.3	44.90
6865	3262	146.5	44.65
6868	3266	146.4	44.60
6871	3271	146.8	44.75
6875	3275	146.4	44.60
6878	3278	146.8	44.75
6880	3282	147.4	44.95
6882	3286	146.8	44.75
6885	3290	146.9	44.80
6887	3295	147.6	45.00
6890	3300	147.1	44.85
6892	3304	146.6	44.70
6895	3308	146.0	44.50
6897	3312	145.0	44.20
6899	3316	145.5	44.35
6901	3320	145.2	44.25
6903	3323	144.4	44.00
6906	3326	144.1	43.90
6910	3328	143.8	43.85
6913	3330	144.0	43.90
6917	3332	143.6	43.75
6921	3333	143.3	43.70
6925	3334	143.0	43.60
6929	3336	143.6	43.75
6933	3338	142.2	43.35
6937	3340	142.1	43.30
6941	3342	142.1	43.30
6945	3344	141.5	43.15
6948	3346	141.7	43.20
6952	3348	141.4	43.10
6955	3350	142.2	43.35
6956	3346	140.4	42.80
6958	3342	139.6	42.55
6959	3337	140.0	42.65
6961	3333	139.3	42.45
6962	3329	137.8	42.00
6964	3325	135.1	41.20
6965	3320	134.1	40.85
6959	3350	140.3	42.75
6963	3351	140.4	42.80
6967	3351	139.7	42.60
6972	3351	139.4	42.50
6976	3351	139.1	42.40
6980	3351	138.2	42.10
6984	3349	137.8	42.00
6987	3346	138.7	42.30
6990	3343	138.6	42.25
6994	3340	138.5	42.20
6998	3337	138.0	42.05
7001	3334	137.4	41.90
7005	3332	134.9	41.10
7008	3330	135.2	41.20
7011	3327	136.1	41.50
7015	3325	135.8	41.40

7019	3323	133.1	40.55
7023	3321	133.8	40.80
7027	3319	134.8	41.10

F 586

7012	3350	123.0	37.50
7013	3348	122.6	37.55
7015	3345	122.8	37.45
7018	3342	122.1	37.20
7022	3339	121.4	37.00
7025	3337	121.7	37.10
7026	3338	120.7	36.80
7027	3339	120.2	36.65
7028	3340	119.9	36.55
7024	3335	121.2	36.95
7028	3334	121.0	36.90
7030	3332	120.3	36.65
7033	3330	118.6	36.15
7036	3329	117.3	35.75
7039	3328	117.3	35.75
7042	3327	115.9	35.35

F 587

6883	3271	167.6	51.10
6886	3275	167.3	51.00
6890	3279	168.5	51.35
6893	3282	167.5	51.05
6896	3285	166.0	50.60
6899	3289	166.1	50.65
6902	3293	165.4	50.40
6905	3296	162.7	49.60
6909	3298	161.5	49.25
6913	3300	160.2	48.85
6918	3302	159.0	48.45
6922	3305	159.5	48.60
6927	3306	159.9	48.75
6930	3301	156.9	47.80
6932	3299	156.5	47.70
6932	3307	159.5	48.60
6936	3308	158.6	48.35
6941	3309	158.4	48.30
6945	3310	156.6	47.75
6950	3311	157.8	48.10
6955	3312	157.5	48.00
6959	3313	155.8	47.50
6964	3314	153.4	46.75

F 588

7026	3346	121.3	36.95
7029	3343	122.4	37.30
7033	3341	121.8	37.10
7037	3338	121.3	36.95
7042	3336	121.1	36.90
7046	3334	121.3	36.95
7052	3333	121.1	36.90
7052	3332	121.3	36.95
7053	3330	121.0	36.90
7053	3329	120.8	36.80
7057	3335	120.4	36.70
7061	3337	119.3	36.35
7066	3339	118.8	36.20
7070	3343	117.6	35.85
7074	3346	117.1	35.70
7078	3349	117.0	35.65

F 589

6977	3359	121.9	37.15
6981	3357	121.9	37.15
6985	3356	122.4	37.30
6989	3354	122.3	37.30
6992	3351	121.9	37.15
6996	3349	121.5	37.05
7000	3347	120.9	36.85
7003	3344	120.6	36.75
7006	3342	120.1	36.60
7009	3339	119.5	36.40
7007	3337	119.9	36.55
7012	3337	120.6	36.75
7015	3334	120.1	36.60
7018	3331	119.1	36.30
7021	3328	118.7	36.20
7024	3325	117.7	35.85

F 590

7035	3345	124.5	37.95
7040	3344	125.0	38.10
7045	3345	124.5	37.95
7050	3346	124.7	38.00
7055	3347	125.0	38.10
7060	3348	122.7	37.40
7066	3348	120.4	36.80

F 591

6980	3356	127.0	38.70
6983	3354	127.1	38.75
6986	3352	126.8	38.65
6990	3350	126.7	38.60

F 592

7092	3374	120.3	36.65
7093	3378	120.3	36.65
7094	3382	118.6	36.15
7095	3386	118.2	36.05

7096	3390	118.4	36.10
7097	3395	117.4	35.80
7097	3399	117.5	35.80
7098	3404	117.6	35.85

F 593

7105	3363	131.2	40.00
7108	3366	129.8	39.55
7111	3369	129.9	39.60
7114	3372	128.7	39.25
7117	3376	127.3	38.80
7119	3380	127.7	38.90
7122	3383	126.5	38.55
7125	3386	127.5	38.85
7128	3389	127.9	39.00
7131	3391	128.0	39.00
7134	3394	128.8	39.25
7135	3392	128.5	39.15
7136	3390	128.3	39.10
7137	3396	128.3	39.10
7141	3399	127.9	39.00
7145	3401	127.0	38.70
7149	3403	127.2	38.75
7152	3405	125.6	38.30

F 594

7096	3371	113.9	34.70
7098	3373	114.4	34.85
7101	3377	113.2	34.50
7103	3380	113.0	34.45
7106	3383	112.5	34.30
7108	3386	112.3	34.25
7111	3389	112.2	34.20

F 595

7102	3365	113.2	34.50
7105	3368	113.7	34.65
7108	3371	113.7	34.65
7110	3375	113.4	34.55
7113	3378	113.1	34.45
7114	3378	113.8	34.70
7116	3381	112.9	34.40
7119	3384	112.4	34.25
7121	3387	112.1	34.15

F 596

7110	3390	115.8	35.30
7112	3392	115.5	35.20
7115	3395	115.6	35.25
7119	3398	114.8	35.00
7122	3400	114.7	34.95
7125	3402	114.5	34.90
7127	3404	114.6	34.95
7124	3407	113.7	34.65
7121	3409	112.9	34.40
7118	3412	112.1	34.15
7115	3414	111.1	33.85
7112	3417	114.5	34.90
7109	3419	114.2	34.80
7128	3406	114.0	34.75
7131	3408	113.6	34.65
7134	3411	113.2	34.50
7138	3415	113.6	34.65
7141	3418	112.8	34.40
7144	3420	112.3	34.25
7147	3424	112.5	34.30
7150	3427	112.2	34.20
7153	3430	111.9	34.10
7156	3433	112.0	34.15
7159	3437	112.3	34.25

F 597

7160	3413	115.0	35.05
7164	3415	115.0	35.05
7168	3417	114.8	35.00
7172	3418	114.6	34.95
7177	3419	114.4	34.85
7181	3419	113.3	34.55
7186	3420	113.0	34.45
7186	3417	112.5	34.30
7186	3414	112.2	34.20
7186	3423	108.2	33.00
7186	3426	108.2	33.00
7185	3429	109.7	33.45
7190	3421	111.5	34.00
7194	2422	110.9	33.80
7199	3423	112.1	34.15

F 598

7089	3404	129.7	39.55
7090	3407	131.2	40.00
7093	3410	131.3	40.00
7097	3414	131.1	39.95
7099	3418	130.3	39.70
7101	3422	129.4	39.45
7103	3426	128.4	39.15
7107	3427	128.2	39.10
7111	3428	129.1	39.35
7112	3427	126.1	38.45
7109	3430	128.3	39.10
7107	3432	128.2	39.10
7105	3435	129.2	39.40
7103	3437	130.0	39.60
7114	3429	127.8	38.95

7118	3432	128.9	39.30
7123	3435	128.7	39.25
7126	3438	127.2	38.75
7129	3443	128.5	39.15
7131	3448	127.3	38.80
7133	3453	126.6	38.60
7135	3457	127.1	38.75

F 599

7150	3412	112.1	34.15
7153	3415	111.8	34.10
7156	3417	111.7	34.05
7159	3420	111.4	33.95
7162	3422	111.0	33.85
7166	3424	111.5	34.00
7165	3426	110.7	33.75
7165	3428	110.4	33.65
7167	3421	108.6	33.10
7168	3418	110.1	33.55
7170	3426	110.3	33.60
7174	3427	110.2	33.60
7178	3427	109.9	33.50
7183	3427	109.7	33.45
7187	3427	108.9	33.20
7192	3427	108.7	33.15
7196	3426	108.3	33.00

F 600

7154	3460	122.7	37.40
7155	3458	121.7	37.10
7137	3438	123.8	37.75
7140	3440	121.1	36.90
7146	3441	122.2	37.25
7144	3446	121.1	36.90
7143	3452	118.7	36.20
7141	3458	118.0	35.95
7151	3443	122.8	37.45
7157	3443	124.2	37.85
7162	3444	123.9	37.75
7168	3444	122.4	37.30
7173	3445	122.5	37.35
7173	3440	119.7	36.50
7173	3451	121.1	36.90
7173	3456	119.8	36.50
7173	3462	117.5	35.80
7179	3445	121.4	37.00
7184	3445	118.5	36.10
7189	3445	118.4	36.10

F 601

7140	3403	116.7	35.55
7145	3406	115.6	35.25
7148	3408	114.9	35.00

F 602

7188	3465	121.5	37.05
7190	3460	122.6	37.35
7193	3454	124.0	37.80
7195	3448	122.0	37.20
7196	3446	122.2	37.25

F 603

7160	3409	120.6	36.75
7165	3410	120.9	36.85
7167	3411	120.7	36.80
7167	3410	120.4	36.70
7168	3409	119.7	36.50
7168	3407	119.5	36.40
7170	3412	120.4	36.70
7175	3413	118.5	36.10
7180	3414	116.7	35.55
7185	3415	116.8	35.60
7190	3416	115.4	35.15
7194	3417	116.1	35.40
7199	3418	115.7	35.25
7203	3418	116.8	35.60

F 604

7202	3453	114.0	34.75
7203	3449	115.0	35.05
7202	3444	114.6	34.95
7201	3440	113.5	34.60
7201	3435	110.8	33.75
7197	3434	110.7	33.75
7206	3434	111.0	33.85
7211	3434	110.3	33.60
7215	3433	110.2	33.60
7220	3433	110.2	33.60

F 606

7205	3431	106.7	32.50
7209	3431	106.4	32.45
7213	3430	105.6	32.20
7217	3430	105.5	32.15
7220	3429	105.7	32.20
7224	3428	106.5	32.45
7228	3427	105.8	32.25
7231	3426	105.5	32.15
7231	3427	105.5	32.15
7230	3425	105.1	32.05
7235	3425	105.4	32.15
7238	3424	105.7	32.20
7241	3423	105.8	32.25
7245	3421	104.8	31.95

7245	3420	104.0	31.70
7245	3422	105.7	32.20
7247	3418	104.3	31.80
7250	3416	104.2	31.75
7253	3413	103.9	31.65
7256	3410	104.6	31.90
7257	3407	104.4	31.80
7258	3403	104.7	31.90

F 607

7190	3379	128.5	39.15
7194	3382	129.3	39.40
7197	3385	129.2	39.40
7200	3388	129.4	39.45
7199	3389	128.5	39.15
7201	3386	129.7	39.55
7202	3384	128.3	39.10
7203	3383	127.2	38.75

F 608

7227	3446	140.3	42.75
7225	3449	139.4	42.50
7223	3452	138.7	42.30
7220	3455	138.3	42.15
7218	3458	138.2	42.10
7216	3462	135.7	41.35
7214	3466	135.5	41.30
7213	3469	136.4	41.55
7211	3472	137.7	41.95
7209	3475	137.8	42.00
7207	3479	137.2	41.80
7205	3482	137.2	41.80

F 614

7274	3392	118.0	35.95
7278	3394	117.3	35.75
7282	3397	115.7	35.25
7286	3400	115.1	35.10
7290	3403	114.4	34.85
7296	3402	114.3	34.85
7300	3402	114.2	34.80
7304	3403	114.7	34.95
7300	3406	116.8	35.60
7297	3410	116.8	35.60
7309	3406	114.3	34.85
7312	3409	114.1	34.80
7315	3412	115.3	35.15
7312	3414	114.6	34.95
7310	3417	114.2	34.80
7307	3420	113.7	34.65
7306	3421	114.1	34.80
7318	3414	114.7	34.95
7321	3416	114.4	34.85
7325	3419	114.0	34.75
7327	3417	112.6	34.30
7330	3416	111.4	33.95
7332	3414	110.3	33.60
7334	3413	108.7	33.15
7323	3417	112.2	34.20
7321	3421	110.6	33.70
7319	3426	110.8	33.75
7317	3430	111.5	34.00
7315	3434	111.7	34.05
7313	3439	111.5	34.00
7312	3442	112.2	34.20
7327	3422	113.9	34.70
7328	3425	113.6	34.65
7331	3427	113.5	34.60
7334	3429	113.0	34.45
7337	3432	112.0	34.15
7340	3434	111.4	33.95
7347	3433	111.6	34.00
7350	3435	110.4	33.65
7354	3437	109.5	33.40
7357	3439	109.4	33.35
7360	3441	109.6	33.40
7363	3444	110.0	33.55
7366	3446	109.8	33.45
7369	3448	108.3	33.00
7373	3452	109.4	33.35
7377	3455	109.7	33.45
7380	3458	108.3	33.00
7383	3461	108.0	32.90
7385	3464	108.0	32.90
7388	3468	108.0	32.90
7391	3471	107.5	32.75
7393	3474	108.3	33.00
7396	3477	107.6	32.80
7398	3480	107.7	32.85
7400	3483	109.1	33.25
7398	3485	106.6	32.50
7396	3487	107.5	32.75

F 616

7308	3367	109.1	33.25

F 617

7202	3361	108.0	32.90
7205	3363	108.3	33.00
7208	3365	107.8	32.85
7211	3368	107.3	32.70
7213	3370	107.5	32.75
7211	3372	105.6	32.20
7209	3373	107.0	32.60
7215	3373	106.3	32.40
7217	3377	105.8	32.25
7219	3380	105.0	32.00

F 618

7287	3362	103.0	31.40
7291	3360	101.4	30.90
7296	3359	101.4	30.90
7300	3360	101.5	30.95
7305	3361	101.3	30.90
7309	3363	101.2	30.85
7313	3365	101.3	30.90
7317	3368	101.0	30.80
7321	3371	100.4	30.60
7323	3375	100.1	30.50

F 619

7208	3402	118.1	36.00
7204	3400	118.3	36.05
7200	3398	116.8	35.60
7212	3404	118.1	36.00
7215	3406	117.8	35.90
7219	3408	116.2	35.40
7211	3400	117.0	35.65
7215	3397	116.3	35.45
7218	3395	116.2	35.40
7222	3393	116.1	35.40

F 620

7327	3382	105.5	32.15
7330	3386	103.6	31.60
7335	3398	104.6	31.90
7333	3399	103.3	31.50
7332	3400	103.1	31.40
7330	3401	103.2	31.45
7336	3403	103.7	31.60
7338	3407	103.4	31.50

F 621

7208	3418	112.9	34.40
7211	3418	115.1	35.10
7215	3418	115.0	35.05
7218	3417	114.3	34.85
7221	3416	113.5	34.60
7225	3416	113.5	34.60
7228	3415	114.2	34.80
7231	3414	113.3	34.55
7228	3412	112.6	34.30
7225	3411	112.6	34.30
7222	3409	113.6	34.65
7234	3411	112.7	34.35
7237	3408	112.4	34.25
7239	3406	112.2	34.20
7241	3403	112.1	34.15
7243	3400	111.7	34.05
7244	3397	111.0	33.85
7245	3394	109.6	33.40

F 624

7372	3475	121.7	37.10
7376	3475	118.8	36.20
7379	3477	120.5	36.75
7382	3479	122.0	37.20
7383	3478	120.9	36.85
7382	3481	121.3	36.95
7381	3482	120.4	36.70
7386	3481	122.1	37.20
7389	3483	120.9	36.85
7391	3485	120.6	36.75
7394	3487	120.6	36.75
7396	3490	121.1	36.90

F 625

7211	3352	115.2	35.10
7215	3354	113.6	34.65
7219	3356	112.8	34.40
7223	3359	112.5	34.30
7227	3362	111.7	34.05
7225	3366	110.4	33.65
7229	3359	113.5	34.60
7230	3355	111.1	33.85
7232	3352	109.7	33.45
7233	3348	109.0	33.20
7235	3345	108.5	33.05
7237	3342	108.6	33.10
7238	3338	107.1	32.65
7240	3335	107.5	32.75
7231	3365	111.1	33.85
7235	3368	111.3	33.90
7239	3371	112.2	34.20
7242	3374	113.4	34.55
7246	3375	111.4	33.95
7250	3372	110.5	33.70
7253	3369	110.2	33.60
7255	3365	109.8	33.45
7258	3361	108.8	33.15
7260	3357	107.7	32.85
7263	3354	107.2	32.65
7262	3350	107.4	32.75
7260	3347	106.4	32.45
7259	3343	105.1	32.05
7257	3339	104.2	31.75
7255	3335	104.1	31.75
7212	3349	116.8	35.60
7214	3346	115.8	35.30
7217	3343	114.7	34.95
7219	3340	113.2	34.50
7222	3338	113.2	34.50
7225	3336	112.8	34.40
7228	3337	112.4	34.25
7232	3337	110.1	33.55
7235	3337	108.8	33.15
7238	3336	107.4	32.75

7242	3336	106.4	32.45
7246	3336	104.7	31.90
7250	3336	103.9	31.65

F 626

7451	3520	94.4	28.75
7454	3522	94.0	28.65
7457	3524	93.9	28.60
7461	3527	93.2	28.40
7464	3529	93.6	28.55
7467	3531	93.4	28.45
7470	3533	93.9	28.60

F 627

7277	3352	112.8	34.40
7280	3349	111.6	34.00
7277	3346	112.3	34.25
7274	3343	112.6	34.30
7271	3341	113.3	34.55
7285	3348	111.3	33.90

F 628

7483	3556	116.8	35.60
7485	3559	116.0	35.35
7486	3562	116.9	35.65
7488	3565	116.8	35.60
7490	3569	116.5	35.50
7492	3572	117.2	35.70
7494	3575	116.5	35.50

F 629

7376	3393	123.9	37.75
7378	3397	123.3	37.60
7380	3401	123.2	37.55
7382	3405	123.0	37.50
7385	3408	122.3	37.30
7388	3406	122.2	37.25
7387	3411	121.0	36.90
7390	3413	120.8	36.80
7393	3416	118.9	36.25

F 630

7480	3548	114.5	34.90
7483	3550	112.9	34.40
7486	3553	110.1	33.55
7488	3555	112.2	34.20
7491	3558	113.0	34.45
7489	3559	112.9	34.40
7493	3561	113.1	34.45
7496	3565	112.6	34.30
7498	3570	111.9	34.10
7502	3581	106.6	32.50
7503	3585	107.9	32.90
7505	3589	106.2	32.35
7507	3593	106.5	32.45
7509	3597	106.6	32.50
7511	3600	106.3	32.40
7513	3603	106.1	32.35
7515	3606	106.6	32.50
7518	3609	106.4	32.45
7518	3613	105.1	32.05
7521	3615	104.7	31.90
7524	3618	106.0	32.30
7525	3623	106.7	32.50
7521	3623	103.1	31.40
7518	3624	102.1	31.10
7525	3627	103.1	31.40

F 631

7375	3418	99.7	30.40
7377	3423	98.7	30.10
7379	3427	99.6	30.35
7382	3430	99.0	30.20
7383	3435	99.9	30.45
7385	3438	100.4	30.60
7387	3442	100.3	30.55
7390	3446	100.1	30.50
7392	3449	100.0	30.50
7395	3453	99.5	30.35
7397	3456	99.2	30.25
7399	3453	99.1	30.20
7401	3451	97.9	29.85
7403	3448	96.8	29.50
7405	3445	101.0	30.80
7400	3459	99.5	30.35
7402	3462	99.6	30.35
7405	3465	99.4	30.30
7408	3468	98.1	29.90
7412	3471	97.3	29.65

F 632

7480	3547	102.5	31.25
7483	3548	102.5	31.25
7487	3550	102.5	31.25
7491	3552	101.5	30.95
7495	3555	101.1	30.80
7499	3558	101.1	30.80
7502	3561	101.2	30.85
7505	3564	100.5	30.65
7507	3568	99.7	30.40
7509	3570	99.1	30.20
7512	3573	99.6	30.35
7516	3575	100.0	30.50

7520	3578	100.6	30.65
7524	3580	99.6	30.35
7528	3582	100.9	30.75
7524	3584	99.4	30.30
7519	3585	98.6	30.05
7515	3587	97.0	29.55
7531	3586	101.6	30.95
7533	3591	101.3	30.90
7534	3595	101.4	30.90
7535	3599	100.9	30.75
7537	3604	100.6	30.65
7535	3608	98.7	30.10
7534	3611	94.2	28.70
7533	3615	93.9	28.60
7536	3620	94.6	28.85
7538	3624	94.6	28.85
7535	3625	95.0	28.95
7532	3626	94.1	28.70
7528	3627	94.1	28.70
7539	3627	94.9	28.95
7540	3630	94.3	28.75
7540	3634	93.4	28.45
7540	3638	92.4	28.15
7540	3642	90.9	28.70
7540	3646	91.3	27.85
7540	3650	90.8	27.70
7540	3654	90.9	27.70
7540	3658	90.8	27.70

F 633

7374	3418	99.5	30.35
7373	3423	99.1	30.20
7374	3427	99.1	30.20
7376	3431	99.1	30.20
7378	3435	99.6	30.35
7381	3438	99.0	30.20
7383	3442	98.1	29.90
7386	3445	97.0	29.55

F 634

7456	3528	97.5	29.70
7460	3530	98.2	29.95
7465	3532	98.1	29.90
7469	3534	97.8	29.80
7473	3536	97.8	29.80
7477	3538	97.2	29.65
7484	3542	95.7	29.15
7488	3544	95.3	29.05
7493	3546	94.5	28.80
7497	3547	94.9	28.95
7502	3549	95.8	29.20
7506	3550	96.2	29.30
7511	3552	96.3	29.35
7515	3553	96.6	29.45
7518	3555	97.0	29.55
7522	3557	96.3	29.35
7525	3560	95.9	29.25
7527	3563	95.1	29.00
7530	3566	94.7	28.85
7532	3569	94.5	28.80
7534	3572	94.1	28.70
7537	3575	93.6	28.55
7539	3578	94.1	28.70
7535	3580	92.0	28.05
7533	3581	91.1	27.75
7542	3576	94.0	28.65
7541	3580	92.9	28.30
7543	3584	91.0	27.75
7544	3588	91.1	27.75
7546	3592	91.2	27.80
7547	3596	91.9	28.00
7548	3600	91.9	28.00
7548	3604	91.5	27.90
7549	3608	91.7	27.95
7550	3613	91.5	27.90
7549	3617	92.0	28.05
7548	3619	92.1	28.05
7547	3623	91.1	27.75
7546	3627	90.5	27.60

F 635

7418	3450	107.3	32.70
7418	3453	106.6	32.50
7419	3459	106.2	32.35
7420	3464	106.7	32.50
7422	3468	105.0	32.00
7425	3464	105.2	32.05
7428	3460	104.0	31.70
7431	3457	104.1	31.75
7433	3458	105.6	32.20
7436	3460	105.3	32.10
7439	3462	106.1	32.35
7443	3464	107.2	32.65
7446	3466	106.8	32.55
7450	3468	106.1	32.35
7454	3471	106.2	32.35
7458	3473	106.0	32.30
7462	3475	106.0	32.30
7466	3477	105.5	32.15
7470	3479	104.9	31.95
7473	3482	104.6	31.90
7474	3486	104.1	31.75
7475	3491	104.1	31.75
7478	3494	104.2	31.75
7482	3494	105.3	32.10
7485	3497	106.1	32.35
7489	3501	104.9	31.95

7492	3504	104.7	31.90
7494	3500	103.1	31.40
7493	3496	104.5	31.85
7497	3504	104.0	31.70
7502	3505	103.0	31.40
7506	3505	102.5	31.25
7510	3505	103.3	31.50
7512	3509	101.5	30.95
7514	3512	100.7	30.70
7516	3516	101.0	30.80
7518	3519	100.0	30.50
7519	3520	100.6	30.65

F 636

7487	3538	92.5	28.20
7491	3539	92.8	28.30
7495	3540	92.8	28.30
7499	3541	92.7	28.25
7502	3542	92.4	28.15
7506	3543	92.9	28.30
7510	3544	92.7	28.25
7510	3546	93.8	28.60
7513	3547	93.8	28.60
7516	3548	94.7	28.85
7519	3549	95.0	28.95
7523	3550	94.8	28.90
7526	3553	94.0	28.65
7530	3555	94.3	28.75
7532	3558	93.5	28.50
7535	3561	93.5	28.50
7537	3565	92.8	28.30
7539	3568	92.6	28.20
7541	3572	91.7	27.95
7543	3575	90.4	27.55

F 637

7424	3476	100.1	30.50
7427	3478	101.0	30.80
7430	3481	100.7	30.70
7433	3484	101.1	30.80
7435	3487	100.5	30.65
7438	3490	99.9	30.45
7440	3493	99.8	30.40
7443	3496	99.6	30.35
7446	3499	99.9	30.45
7450	3502	99.7	30.40
7453	3505	99.5	30.35
7456	3507	99.4	30.30
7459	3509	98.7	30.10
7463	3510	98.2	29.95
7467	3511	97.7	29.80
7471	3512	96.8	29.50
7475	3513	95.9	29.25

7479	3514	96.5	29.40
7483	3515	96.9	29.55
7480	3519	97.3	29.65
7478	3523	96.1	29.30
7480	3511	96.1	29.30
7477	3509	95.8	29.30
7487	3518	96.6	29.45
7491	3520	96.1	29.30
7495	3522	95.6	29.15
7499	3524	94.9	28.95
7502	3526	95.0	28.95
7506	3528	95.0	28.95
7510	3530	95.3	29.05

F 638

7525	3658	114.4	34.85
7526	3664	114.8	35.00
7529	3667	113.8	34.70
7532	3670	113.3	34.55
7536	3672	112.8	34.40
7540	3675	112.8	34.40
7544	3678	112.6	34.30
7548	3680	112.5	34.30
7552	3682	110.6	33.70
7556	3684	109.9	33.50
7560	3686	109.8	33.45
7564	3687	110.6	33.70
7569	3687	110.1	33.55
7572	3685	111.1	33.85
7576	3687	110.2	33.60
7580	3689	108.6	33.10
7583	3691	107.1	32.65
7587	3694	106.2	32.35

F 639

7496	3488	120.9	36.85
7501	3490	120.9	36.85
7505	3492	122.0	37.20
7510	3494	122.2	37.25
7513	3496	121.1	36.90
7516	3493	120.9	35.85
7518	3498	120.5	36.75
7522	3500	120.2	36.65
7527	3501	120.0	36.60

F 641

7538	3547	91.8	28.00
7540	3548	92.0	28.05

F 642

7587	3688	92.3	28.15

7591	3690	91.9	28.00
7595	3693	91.2	27.80
7599	3695	91.1	27.75
7602	3698	90.7	27.65
7606	3700	89.7	27.35
7601	3703	89.4	27.25
7614	3705	89.6	27.30
7617	3708	89.2	27.20
7621	3710	88.9	27.10
7624	3712	88.2	26.90
7625	3714	88.5	26.95
7628	3710	87.3	26.60
7622	3716	88.4	26.95
7628	3712	90.6	27.60
7630	3716	89.8	27.35
7632	3720	89.1	27.15
7634	3723	88.4	26.95
7637	3727	88.0	26.80
7641	3730	87.8	26.75
7644	3733	87.3	26.60
7647	3736	86.8	26.45
7650	3739	85.7	26.10
7653	3742	82.7	25.20
7656	3745	82.0	25.00
7659	3749	80.6	24.55
7655	3750	77.9	23.75

F 643

7535	3522	114.6	34.95
7539	3524	115.2	35.10
7543	3526	118.2	36.05
7546	3528	118.6	36.15
7548	3527	118.5	36.10
7550	3530	116.4	35.50

F 644

7625	3724	101.9	31.05
7628	3727	101.4	30.91
7631	3730	101.8	31.05
7635	3733	99.6	30.35
7638	3736	97.5	29.70
7641	3738	95.3	29.05
7644	3741	96.7	29.45
7647	3744	97.6	29.75
7644	3747	95.0	28.95
7648	3748	97.3	29.65

F 645

7523	3536	100.6	30.65
7527	3537	98.9	30.15
7530	3539	98.2	29.95
7533	3541	97.6	29.75
7537	3543	96.8	29.50
7541	3547	97.0	29.55
7544	3551	97.7	29.80
7547	3555	97.3	29.65
7550	3558	97.0	29.55
7554	3555	97.5	29.70
7557	3553	97.1	29.60
7561	3550	96.6	29.45
7565	3547	95.9	29.25
7552	3562	96.0	29.25
7554	3566	96.0	29.25
7555	3569	95.6	29.15
7557	3573	94.0	28.65
7559	3577	94.0	28.65
7561	3580	93.8	28.60
7563	3583	93.2	28.40
7565	3587	92.9	28.30
7567	3590	93.2	28.40
7568	3593	93.7	28.55

F 646

7628	3742	101.9	31.05
7630	3746	102.2	31.15
7632	3749	102.6	31.25
7634	3753	102.3	31.20
7631	3754	100.6	30.65
7627	3755	102.1	31.10
7624	3754	102.1	31.10

F 647

7559	3583	90.9	27.70
7560	3587	90.7	27.65
7561	3591	91.1	27.75
7562	3595	91.4	27.85
7563	3597	91.4	27.85

F 648

7618	3788	86.1	26.25
7622	3786	85.0	25.90
7625	3783	82.5	25.15
7629	3781	82.0	25.00
7632	3778	81.5	24.85
7635	3775	81.9	24.95
7638	3772	81.3	24.80
7641	3769	82.0	25.00
7639	3766	82.1	25.00
7636	3763	81.9	24.95
7633	3760	81.6	24.85
7645	3766	81.1	24.70
7648	3762	81.2	24.75
7651	3759	79.2	24.15
7654	3756	78.5	23.95

F 649

7596	3563	115.3	35.15

7598	3560	114.4	34.85
7599	3566	114.7	34.95
7602	3569	113.8	34.70
7605	3572	114.6	34.95
7608	3574	115.2	35.10
7611	3589	115.3	35.15
7615	3593	115.8	35.30
7617	3597	116.2	35.40
7612	3581	116.0	35.35
7613	3585	115.4	35.15
7611	3589	114.7	34.95
7609	3593	112.1	34.15
7606	3597	111.6	34.00
7604	3600	111.3	33.90
7601	3603	110.6	33.70
7599	3607	110.1	33.55
7596	3610	111.0	33.85
7592	3608	111.1	33.85
7567	3608	112.2	34.20
7570	3611	111.3	33.90
7572	3614	110.7	33.75
7574	3617	110.1	33.55
7576	3620	110.1	33.55
7579	3623	109.4	33.35
7582	3626	108.0	33.90
7585	3629	107.3	32.70
7588	3632	107.0	32.60
7590	3635	104.5	31.85
7593	3638	103.6	31.60
7595	3642	103.8	31.65
7598	3645	102.4	31.20
7600	3648	101.0	30.80
7602	3651	100.4	30.60

F 652

7665	3755	87.2	26.60
7668	3758	87.5	26.65
7672	3761	87.4	26.65
7675	3764	87.5	26.65
7679	3767	87.1	26.55
7682	3770	86.9	26.50
7685	3773	86.2	26.25
7689	3776	85.5	26.05
7692	3780	85.1	25.95
7696	3783	85.3	26.00
7699	3786	84.9	25.90
7696	3789	83.4	25.40
7702	3789	84.1	25.65
7705	3793	84.4	25.75
7709	3796	85.0	25.90
7712	3799	85.7	26.10
7716	3802	85.2	25.95
7719	3805	84.0	25.60
7722	3809	83.2	25.35
7725	3812	83.7	25.50
7728	3815	83.2	25.35
7725	3819	81.6	24.85
7731	3818	82.6	25.20
7736	3819	81.6	24.85

F 653

7565	3624	98.7	30.10
7567	3628	98.2	29.95
7569	3632	97.7	29.80
7571	3635	97.7	29.80
7573	3639	96.4	29.40
7575	3642	96.8	29.50
7577	3646	96.6	29.45
7579	3650	95.7	29.15
7580	3654	96.0	29.25
7582	3657	95.6	29.15
7584	3660	95.3	29.05
7586	3663	95.2	29.00
7590	3666	94.5	28.80
7593	3668	94.4	28.75
7597	3669	93.7	28.55
7600	3670	93.1	28.40
7603	3672	91.2	27.80

F 654

7660	3772	94.3	28.75
7663	3775	93.7	28.55
7666	3779	93.0	28.35
7662	3782	93.8	28.60
7659	3786	94.3	28.75
7655	3789	94.3	28.75
7652	3792	94.7	28.85
7649	3795	95.8	29.20
7669	3782	92.6	28.20
7672	3786	92.1	28.05
7674	3787	94.5	28.80
7677	3790	93.6	28.55
7680	3788	91.2	27.80
7673	3794	92.6	28.20
7670	3798	91.9	28.00
7667	3801	91.9	28.00
7680	3793	92.1	28.05
7684	3796	94.5	28.80
7688	3799	94.6	28.85
7691	3802	93.9	28.60
7695	3805	94.0	28.65
7698	3809	97.8	29.80
7700	3808	98.3	29.95
7695	3812	92.8	28.30
7692	3815	88.9	27.10
7689	3818	88.9	27.10
7701	3812	97.0	29.55
7704	3815	95.9	29.25
7707	3818	95.8	29.20

7704	3822	91.6	27.90
7701	3825	89.2	27.20
7710	3822	93.9	28.60
7716	3825	91.1	27.75
7713	3829	90.7	27.65
7710	3833	90.1	27.45
7720	3828	90.0	27.45
7724	3831	89.7	27.35
7728	3832	88.0	26.80
7732	3834	88.2	26.90
7737	3835	88.9	27.10
7742	3836	89.7	27.35
7746	3837	90.4	27.55
7750	3838	89.3	27.20
7754	3841	88.2	26.90
7758	3844	86.8	26.45

F 656

7738	3830	86.6	26.40
7742	3830	85.9	26.20
7745	3831	84.6	25.80

F 657

7557	3632	90.5	27.60
7557	3636	89.9	27.40
7556	3639	90.5	27.60
7556	3643	91.7	27.95
7555	3647	92.7	28.25
7557	3650	90.7	27.65
7560	3650	91.2	27.80
7562	3653	90.9	27.70
7565	3656	90.2	27.50
7568	3659	89.3	27.20
7571	3662	88.1	26.85
7573	3665	86.4	26.35

F 658

7766	3849	98.5	30.00
7770	3852	100.0	30.50
7767	3855	99.0	30.20
7763	3858	98.2	29.95
7759	3860	97.0	29.55
7754	3861	97.9	29.85
7750	3863	98.8	30.10
7746	3862	98.0	29.85
7741	3862	98.1	29.90
7774	3854	98.4	30.00

F 660

7835	3863	94.5	28.80
7827	3868	95.3	29.05
7839	3862	94.2	28.70
7843	3861	93.5	28.50
7847	3860	92.3	28.15
7851	3860	93.1	28.40
7855	3859	92.9	28.30
7859	3859	93.1	28.40
7863	3858	92.8	28.30
7867	3859	93.5	28.50
7870	3862	94.0	28.65
7871	3861	93.0	28.35
7872	3860	90.1	27.45
7868	3865	92.6	28.20
7865	3867	91.4	27.85
7863	3870	91.1	27.75
7873	3864	93.8	28.60
7876	3867	93.2	28.40
7879	3870	92.6	28.20
7881	3872	91.9	28.00
7884	3875	90.5	27.60
7887	3878	88.8	27.05
7891	3880	87.8	26.75
7895	3882	88.2	26.90
7899	3883	87.8	26.75
7903	3884	86.9	26.50
7908	3884	88.1	26.85
7912	3884	88.7	27.05
7916	3883	88.2	26.90
7920	3883	88.3	26.90
7924	3884	87.7	26.75
7928	3885	87.9	26.80

F 661

7606	3673	91.0	27.75
7609	3675	90.1	27.45
7613	3676	89.5	27.30
7616	3678	88.6	27.00
7620	3680	88.3	26.90
7624	3681	89.1	27.15
7628	3683	89.6	27.30
7631	3686	89.5	27.30
7635	3688	89.6	27.30
7639	3690	91.7	27.95
7642	3692	92.9	28.30
7639	3697	93.7	28.55
7642	3694	93.7	28.55
7645	3691	92.3	28.15
7642	3699	92.0	28.05
7645	3702	92.5	28.20
7647	3705	92.4	28.15
7650	3708	92.6	28.20
7652	3711	91.7	27.95
7654	3714	90.9	27.70
7656	3717	90.3	27.50
7658	3720	89.7	27.35

7661	3722	89.6	27.30
7664	3724	89.1	27.15
7666	3727	87.4	26.65
7668	3730	85.0	25.90
7670	3734	85.7	26.10
7672	3737	87.6	26.70

F 662

7871	3850	76.6	23.35
7875	3848	75.8	23.10
7879	3845	75.8	23.10
7882	3843	76.3	23.25
7885	3840	74.8	22.80
7887	3828	76.7	23.40
7889	3824	77.3	23.55
7891	3821	77.3	23.55
7893	3818	77.0	23.45
7896	3815	77.6	23.65
7899	3811	77.6	23.65
7902	3807	77.0	23.45
7905	3803	76.0	23.15
7907	3811	77.0	23.45
7907	3815	77.2	23.55
7906	3819	76.7	23.40
7906	3823	76.4	23.30
7905	3827	76.1	23.20
7905	3831	76.6	23.35
7905	3835	75.7	23.05
7904	3839	71.9	21.90
7904	3843	74.4	22.70
7904	3847	73.4	22.35
7903	3850	75.0	22.85
7903	3854	75.0	22.85
7903	3858	75.5	23.00
7903	3862	74.7	22.75
7902	3865	73.3	22.35
7902	3869	72.1	22.00
7908	3805	76.5	23.30
7911	3808	75.6	23.05
7914	3812	74.8	22.80
7918	3815	74.4	22.70
7921	3818	74.0	22.55
7924	3822	73.7	22.45
7926	3825	73.1	22.30
7928	3828	73.1	22.30
7930	3832	73.5	22.40
7932	3836	73.0	22.25
7933	3840	73.2	22.30
7935	3843	72.3	22.05
7938	3846	73.0	22.25
7941	3848	72.9	22.20
7944	3852	73.1	22.30
7947	3855	72.9	22.20
7946	3859	72.3	22.05

7946	3864	71.4	21.75
7946	3868	70.6	21.50
7946	3873	70.9	21.60
7945	3876	71.9	21.90
7944	3880	72.1	22.00
7943	3884	73.0	22.25

F 663

7613	3654	101.7	31.00
7616	3657	103.3	31.50
7619	3659	103.5	31.55
7622	3662	104.6	31.90
7625	3665	105.2	32.05
7626	3663	102.8	31.35
7627	3660	99.9	30.45
7627	3667	106.0	32.30
7630	3670	102.9	31.35
7632	3672	100.6	30.65
7635	3675	98.7	30.10

F 664

7884	3827	71.6	21.80
7886	3823	71.7	21.85
7889	3819	72.0	21.95
7891	3815	71.8	21.90
7893	3812	72.1	22.00
7895	3808	72.0	21.95
7898	3805	71.2	21.70
7900	3802	71.6	21.80
7903	3799	69.7	21.25
7908	3799	70.0	21.35
7908	3801	73.2	22.30
7913	3801	73.4	22.35
7918	3802	72.5	22.10
7922	3804	71.8	21.90
7926	3806	71.0	21.65
7930	3808	71.3	21.75
7934	3810	71.4	21.75
7938	3812	71.6	21.80
7941	3815	71.5	21.80
7944	3818	71.0	21.65
7947	3821	70.9	21.60
7949	3825	69.5	21.20
7950	3830	69.8	21.30
7951	3834	69.0	21.05
7952	3838	68.9	21.00
7952	3842	66.9	20.40
7952	3847	66.4	20.25
7952	3851	67.7	20.65
7953	3856	68.0	20.75
7954	3860	67.5	20.55
7954	3865	67.2	20.50
7955	3869	67.7	20.65

7955	3874	66.2	20.20
7956	3879	67.5	20.55
7957	3884	68.0	20.75
7959	3888	68.7	20.95

F 665

7643	3672	108.2	33.00
7646	3674	108.4	33.05
7649	3677	108.2	33.00
7652	3679	107.5	32.75
7653	3678	106.7	32.50
7655	3675	104.7	31.90
7658	3672	104.0	31.70
7653	3680	106.6	32.50
7655	3683	106.4	32.45
7658	3685	106.1	32.35
7661	3688	104.9	31.95
7664	3690	105.4	32.15
7667	3693	105.4	32.15
7670	3695	105.1	32.05
7673	3698	104.8	31.95
7676	3700	104.7	31.90
7679	3703	105.1	32.05
7682	3705	103.9	31.65
7685	3708	101.3	30.90
7689	3709	99.7	30.40
7690	3712	101.7	31.00
7692	3716	99.6	30.35
7695	3720	98.8	30.10
7698	3723	98.7	30.10
7700	3727	97.6	29.75

F 667

7668	3711	93.3	28.45
7670	3714	92.1	28.05
7673	3716	92.5	28.20
7676	3719	92.5	28.20
7678	3722	93.6	28.55
7680	3725	94.2	28.70
7681	3726	90.8	27.70
7684	3729	90.8	27.70
7687	3732	90.7	27.65
7689	3735	89.2	27.20
7686	3737	89.7	27.35
7684	3740	90.3	27.50
7681	3742	91.2	27.80
7692	3732	89.6	27.30
7695	3730	88.5	26.95
7695	3735	88.6	26.95
7697	3738	88.1	26.85
7699	3741	87.1	26.55
7702	3744	85.4	26.05
7704	3747	85.1	25.95
7706	3751	84.2	25.65
7708	3755	83.8	25.55
7709	3758	85.1	25.95
7710	3762	85.0	25.90
7710	3766	84.7	25.80
7711	3769	84.9	25.90
7711	3773	85.1	25.95
7711	3777	85.4	26.05

F 669

7692	3747	98.8	30.10
7694	3750	99.8	30.40
7696	3753	100.7	30.70
7698	3756	100.2	30.55
7700	3760	98.4	30.00
7702	3763	97.9	29.85
7703	3767	97.1	29.60
7705	3770	93.5	28.50

F 671

7693	3743	96.8	29.50
7698	3745	97.2	29.65
7701	3748	97.4	29.70

F 672

8063	3938	88.8	27.10
8066	3936	87.6	26.70
8070	3936	87.8	26.75
8075	3936	89.3	27.20
8079	3937	89.0	27.15
8083	3937	89.0	27.15
8080	3940	87.3	26.60
8077	3943	85.8	26.15
8073	3946	84.5	25.75
8070	3949	84.5	25.75
8087	3938	87.3	26.60
8091	3939	86.2	26.25
8095	3940	86.3	26.30
8099	3941	84.5	25.75
8103	3942	83.9	25.55
8108	3942	85.1	25.95
8112	3943	86.4	26.35
8117	3943	85.4	26.05

F 673

7723	3764	104.1	31.75
7725	3768	102.4	31.20
7729	3769	102.3	31.20
7733	3770	101.9	31.05
7737	3770	102.1	31.10
7741	3771	100.5	30.65
7745	3772	99.6	30.35
7749	3774	98.9	30.15

F 674

8130	3943	97.7	29.80
8130	3948	94.5	28.80
8135	3944	97.4	29.70
8140	3943	96.1	29.30

F 675

7741	3766	107.5	32.75
7749	3770	108.0	32.90
7758	3771	100.8	30.70
7762	3772	99.1	30.20
7766	3771	99.6	30.35
7770	3772	99.2	30.25
7775	3773	97.9	29.85
7780	3773	97.5	29.70
7785	3773	97.5	29.70
7789	3774	96.3	29.35
7793	3775	95.7	29.15

F 676

8167	3938	78.9	24.05
8167	3934	76.0	23.15
8168	3930	76.9	23.45
8167	3926	76.7	23.40
8165	3924	76.1	23.20
8160	3924	76.6	23.35

F 677

7714	3780	85.5	26.05
7718	3783	85.1	25.95
7722	3786	84.8	25.85
7726	3784	84.6	25.80
7731	3784	84.8	25.85
7736	3783	85.4	26.05
7741	3783	85.2	25.95
7746	3784	85.1	25.95
7750	3785	85.3	26.00
7751	3786	85.1	25.95
7749	3790	85.1	25.95
7753	3781	84.4	25.75
7755	3777	82.8	25.25
7755	3786	85.2	25.95
7759	3787	84.5	25.75
7763	3788	83.7	25.50
7767	3789	84.0	25.60
7771	3790	83.4	25.40
7775	3790	82.9	25.25
7780	3790	82.8	25.25
7784	3789	82.8	25.25
7788	3789	83.2	25.35
7786	3793	79.4	24.20
7790	3786	80.5	24.55
7792	3783	79.4	24.20
7794	3780	78.9	24.05
7792	3789	81.9	24.95
7797	3789	82.0	25.00
7801	3789	81.6	24.85
7805	3789	81.8	24.95
7810	3789	82.2	25.05
7814	3789	82.0	25.00
7818	3788	82.2	25.05
7822	3786	82.3	25.10
7826	3785	81.6	24.85
7831	3785	81.2	24.75
7835	3784	80.7	24.60
7840	3784	79.8	24.30
7844	3783	79.4	24.20
7849	3783	78.6	23.95
7853	3783	78.1	23.80
7858	3783	77.2	23.55
7862	3784	76.0	23.15
7867	3784	76.0	23.15

F 678

8180	3938	78.0	23.75
8182	3934	77.5	23.60
8178	3934	77.2	23.55
8183	3931	77.7	23.70
8185	3928	76.6	23.35
8189	3926	76.4	23.30
8193	3925	75.6	23.05
8196	3923	74.3	22.65

F 679

7729	3661	176.4	53.75
7732	3664	177.5	54.10
7735	3667	178.9	54.55
7738	3670	178.2	54.30
7741	3672	178.0	54.25
7744	3675	178.2	54.30
7747	3678	177.9	54.20
7750	3681	176.8	53.90
7754	3684	176.4	53.75
7757	3687	174.8	53.30
7759	3683	172.0	52.45
7762	3680	174.8	53.30
7754	3691	172.3	52.50
7751	3694	174.1	53.05
7749	3698	172.8	52.65
7746	3701	171.6	52.30
7743	3704	170.4	51.95
7741	3707	170.0	51.80
7760	3690	173.1	52.75
7764	3693	171.6	52.30

7767	3697	170.7	52.05
7770	3700	169.7	51.70
7773	3702	169.2	51.55
7777	3704	168.5	51.35
7780	3706	164.0	50.00
7784	3707	167.5	51.05
7782	3711	164.0	50.00
7779	3714	161.0	49.05
7777	3717	166.8	50.85
7775	3721	167.7	51.10
7773	3724	168.2	51.25
7771	3728	169.6	51.70
7769	3731	170.4	51.95
7786	3704	168.0	51.20
7789	3700	168.1	51.25
7791	3697	171.9	52.40
7788	3708	168.4	51.35
7792	3710	167.3	51.00
7796	3711	165.5	50.45
7800	3713	165.7	50.50
7804	3715	163.4	49.80
7808	3717	162.0	49.40
7812	3719	162.4	49.50
7815	3721	162.1	49.40
7818	3724	160.3	48.85
7821	3727	159.6	48.65
7824	3730	158.3	48.25
7826	3734	159.2	48.50
7829	3736	159.7	48.70
7833	3738	158.2	48.20

F 680

8182	3915	66.5	20.25
8186	3913	65.5	19.95
8190	3911	64.4	19.65
8195	3910	64.2	19.55

F 681

7742	3805	84.0	25.60
7745	3806	83.7	25.50
7747	3809	83.6	25.50
7750	3812	83.3	25.40
7753	3815	83.6	25.50
7756	3815	82.5	25.15
7760	3815	81.6	24.85
7764	3815	82.6	25.20
7768	3816	82.1	25.00
7772	3816	82.2	25.05
7776	3817	82.4	25.10
7773	3821	81.5	24.85
7771	3825	77.9	23.75
7769	3829	79.8	24.30
7779	3818	81.5	24.85
7782	3819	81.5	24.85
7785	3820	80.9	24.65
7789	3821	80.4	24.50
7792	3822	79.5	24.25
7796	3823	79.5	24.25
7800	3824	80.1	24.40
7803	3825	80.0	24.40
7802	3829	77.2	23.55
7800	3833	76.9	23.45
7799	3837	80.0	24.40
7797	3840	80.0	24.40
7796	3844	79.5	24.25
7794	3847	78.2	23.85
7798	3848	78.8	24.00
7802	3848	79.2	24.15
7806	3849	79.3	24.15
7810	3849	78.7	24.00
7815	3849	78.2	23.85
7819	3849	77.7	23.70
7823	3849	77.2	23.55
7825	3846	75.9	23.15
7827	3842	76.9	23.45
7829	3838	78.7	24.00
7830	3834	78.7	24.00
7832	3831	78.1	23.80
7834	3827	78.4	23.90
7836	3832	77.5	23.60
7840	3833	77.6	23.65
7844	3834	77.6	23.65
7848	3834	76.5	23.30
7852	3833	76.4	23.30
7855	3832	76.5	23.30
7859	3832	75.0	22.85
7862	3829	75.9	23.15
7864	3826	75.5	23.00
7866	3823	74.8	22.80
7869	3820	73.8	22.50
7871	3817	73.2	22.30
7874	3814	72.9	22.20
7876	3811	73.0	22.25
7878	3808	73.1	22.30
7880	3805	73.1	22.30
7882	3801	73.0	22.25
7885	3798	72.6	22.15
7887	3794	73.4	22.35
7890	3791	73.3	22.35
7893	3788	73.3	22.35

F 682

8200	3909	66.9	20.40
8204	3909	65.0	19.80
8208	3910	64.9	19.80

F 683

7858	3780	76.8	23.40
7862	3781	75.9	23.15
7866	3781	75.4	23.00

7870	3782	75.0	22.85
7874	3782	75.0	22.85
7878	3783	75.0	22.85
7882	3783	74.6	22.75

F 684

8210	3918	70.9	21.60
8209	3922	71.0	21.65
8214	3917	71.4	21.75
8218	3916	71.5	21.80
8222	3915	70.1	21.35
8226	3915	69.8	21.30
8230	3914	69.3	21.10
8234	3914	69.4	21.15
8238	3913	68.9	21.00
8242	3913	68.7	20.95

F 685

7917	3787	72.7	22.15
7921	3788	72.4	22.05
7926	3789	72.9	22.20
7930	3791	72.1	22.00
7934	3792	71.8	21.90
7938	3794	72.2	22.00
7941	3789	72.0	21.95
7940	3792	73.7	22.45
7939	3793	71.8	21.90
7938	3795	70.2	21.40
7942	3797	72.2	22.00
7946	3799	72.1	22.00
7949	3803	71.7	21.85
7951	3806	71.0	21.65
7953	3810	69.7	21.25
7956	3813	69.1	21.05
7959	3816	69.3	21.10
7961	3820	70.1	21.35
7962	3825	70.7	21.55
7963	3829	70.4	21.45
7965	3833	67.7	20.65
7964	3837	67.9	20.70

F 686

8214	3908	62.4	19.00
8218	3907	62.2	18.95
8222	3906	62.3	19.00
8225	3906	61.2	18.65
8228	3905	60.2	18.35
8232	3905	60.0	18.30
8236	3904	60.4	18.40
8240	3902	60.4	18.40
8242	3899	60.7	18.50
8246	3898	60.5	18.45
8250	3898	61.0	18.60
8254	3898	60.9	18.55
8258	3897	60.7	18.50
8262	3897	60.2	18.35
8266	3898	59.9	18.25
8270	3898	59.3	18.05
8374	3899	59.0	18.00
8278	3899	59.1	18.00
8282	3899	59.0	18.00
8286	3900	58.4	17.80
8290	3901	58.4	17.80
8295	3902	58.6	17.85
8298	3905	59.1	18.00
8297	3909	57.2	17.45
8302	3906	58.8	17.90
8306	3907	58.3	17.75
8311	3908	58.2	17.75
8315	3909	57.6	17.55
8319	3910	56.3	17.15
8322	3911	57.1	17.40

F 687

7981	3823	93.2	28.40
7982	3824	92.7	28.25
7986	3826	92.2	28.10
7989	3828	92.6	28.20
7987	3833	88.6	27.00
7990	3835	89.0	27.15
7993	3837	90.8	27.70
7994	3836	92.6	28.20
7997	3837	91.0	27.75
8000	3840	91.7	27.95
8004	3842	89.8	27.35
8009	3843	89.1	27.15
8014	3844	93.6	28.55
8018	3846	94.9	28.95
8022	3848	94.5	28.80
8026	3850	92.1	28.05
8031	3851	90.8	27.70
8036	3852	90.4	27.55
8040	3853	90.0	27.45
8041	3850	89.0	27.15
8042	3846	90.1	27.45
8043	3845	91.7	27.95
8038	3858	87.4	26.65
8037	3863	87.7	26.75
8035	3867	87.0	26.50
8034	3872	87.0	26.50
8044	3855	89.3	27.20
8048	3857	89.6	27.30
8052	3858	87.7	26.75
8057	3860	85.8	26.15
8061	3861	84.7	25.80
8065	3863	84.8	25.85
8074	3866	84.6	25.80
8078	3868	85.5	26.05

8082	3869	85.1	25.95
8086	3871	83.4	25.40
8085	3878	81.0	24.70
8084	3882	82.0	25.00
8083	3886	82.9	25.25
8082	3890	81.4	24.80
8078	3893	79.0	24.10
8088	3872	82.9	25.25
8093	3873	82.3	25.10
8098	3874	81.5	24.85
8102	3875	80.8	24.65
8103	3871	80.1	24.40
8103	3867	79.5	24.25
8104	3863	80.8	24.65
8101	3876	82.2	25.05
8106	3875	81.8	24.95
8110	3875	81.5	24.85
8115	3875	81.6	24.85
8115	3878	81.3	24.80
8114	3882	80.5	24.55
8113	3886	79.2	24.15
8112	3891	77.4	23.60
8111	3895	77.9	23.75
8110	3899	77.3	23.55
8120	3875	81.7	24.90
8124	3876	81.3	24.80
8128	3877	80.9	24.65
8132	3875	79.9	24.35

F 688

8252	3888	54.9	16.75
8255	3887	54.8	16.70
8259	3887	54.9	16.75
8263	3887	55.3	16.85
8267	3887	55.6	16.95
8272	3887	56.0	17.05
8276	3888	55.8	17.00
8280	3888	55.7	17.00
8284	3888	55.5	16.90
8288	3888	55.2	16.80
8293	3889	54.8	16.70
8298	3890	55.3	16.85
8301	3892	55.3	16.85
8305	3892	56.2	17.15
8308	3893	55.8	17.00
8312	3894	55.3	16.85
8316	3895	55.2	16.80
8321	3896	54.7	16.65
8326	3898	55.3	16.85
8330	3899	55.4	16.90
8334	3900	56.0	17.05
8338	3900	56.1	17.10
8342	3901	55.5	16.90
8345	3903	55.4	16.90
8349	3905	54.9	16.75
8353	3906	54.4	16.60
8357	3907	53.9	16.45
8361	3907	53.7	16.35
8365	3907	52.4	15.95
8369	3908	52.9	16.10
8373	3908	52.7	16.05
8377	3909	52.7	16.05

F 689

7970	3837	91.1	27.75
7973	3840	89.4	27.25
7974	3841	86.8	26.45
7977	3844	84.6	25.80
7981	3846	84.1	25.65
7984	3848	81.9	24.95
7988	3850	81.7	24.90
7992	3852	80.9	24.65
7993	3849	80.8	24.65
7994	3847	80.9	24.65
7995	3844	82.1	25.00
7996	3841	85.5	26.05
7994	3853	81.5	24.85

F 690a

8275	3930	110.3	33.60
8279	3928	109.7	33.45
8279	3924	107.7	32.85
8280	3921	107.7	32.85
8280	3918	108.7	33.15
8284	3928	107.9	32.90
8288	3928	106.4	32.45
8293	3928	105.2	32.05
8297	3928	103.7	31.60

F 690b

8322	3919	89.0	27.15
8326	3914	87.3	26.60
8330	3914	85.5	26.05

F 691

7965	3845	77.6	23.65
7968	3848	76.2	23.25
7971	3852	74.8	22.80
7972	3851	74.4	22.70
7973	3850	73.1	22.30
7975	3855	73.1	22.30
7978	3858	73.0	22.25
7982	3860	73.9	22.50
7987	3860	74.1	22.60
7990	3858	74.1	22.60

7990	3858	74.1	22.60
7993	3861	72.0	21.95
7997	3864	71.5	21.80
8000	3868	70.7	21.55
8004	3871	70.1	21.35
8008	3874	67.8	20.65
8011	3878	70.3	21.45
8013	3874	70.2	21.40
8016	3870	72.2	22.00
8019	3866	73.3	22.35

F 693

7970	3856	70.4	21.45
7973	3859	70.2	21.40
7976	3862	70.3	21.45
7979	3865	70.3	21.45
7983	3867	70.1	21.35
7983	3877	70.2	21.40
7987	3879	70.3	21.45
7991	3881	70.0	21.35
7995	3882	68.1	20.75
8000	3882	66.7	20.35
8005	3881	66.6	20.30
8009	3880	66.7	20.35

F 694

8435	3949	47.3	14.40
8439	3947	46.2	14.10
8442	3944	46.2	14.10
8445	3941	46.0	14.00
8448	3938	46.5	14.15
8451	3936	47.1	14.35
8454	3933	46.7	14.25
8456	3930	45.2	13.80
8460	3926	45.2	13.80
8463	3922	45.4	13.85
8466	3919	45.1	13.75
8470	3916	45.5	13.85
8473	3912	45.7	13.95
8477	3909	45.2	13.80

F 695

7963	3846	72.3	22.05
7963	3850	70.8	21.60
7964	3854	70.5	21.50
7964	3859	70.5	21.50
7964	3863	70.2	21.40
7965	3867	69.9	21.30
7965	3871	69.7	21.25
7966	3876	69.7	21.25
7968	3880	69.2	21.10
7971	3883	68.9	21.00
7975	3884	69.1	21.05

7979	3885	67.9	20.70
7980	3880	67.1	20.45
7982	3876	69.8	21.30
7983	3871	68.9	21.00
7985	3867	70.5	21.50
7986	3862	69.6	21.20
7984	3885	67.6	20.60
7988	3884	67.9	20.70
7992	3884	66.9	20.40
7996	3883	65.8	20.05

F 698

8412	3963	59.5	18.15
8415	3965	60.3	18.40
8417	3967	61.3	18.70
8420	3969	63.5	19.35

F 699

8080	3917	67.9	20.70
8084	3917	67.6	20.60
8088	3918	67.5	20.55
8092	3919	67.9	20.70
8096	3920	68.3	20.80
8100	3921	68.4	20.85
8105	3923	68.5	20.90
8106	3919	68.4	20.85
8107	3915	65.7	20.05
8109	3911	66.6	20.30
8110	3906	66.6	20.30
8109	3922	68.3	20.80
8114	3921	68.4	20.85
8120	3920	68.1	20.75
8124	3920	67.6	20.60
8127	3919	66.8	20.35
8131	3917	66.3	20.20
8135	3915	66.5	20.25
8140	3913	66.1	20.15
8143	3911	66.0	20.10
8146	3910	66.5	20.25
8148	3907	65.1	19.85
8151	3905	64.4	19.65
8154	3902	63.6	19.40
8158	3900	64.3	19.60
8160	3898	64.4	19.65

F 700

8416	3958	55.0	16.75
8419	3960	55.5	16.90
8422	3961	56.0	17.05
8425	3963	56.2	17.15
8428	3964	57.2	17.45
8427	3966	57.7	17.60
8430	3961	57.8	17.60
8431	3966	57.7	17.60

8435	3967	58.9	17.95
8436	3965	57.6	17.55

F 701

8136	3920	62.3	19.00
8140	3918	61.9	18.85
8144	3916	61.8	18.85
8147	3915	62.5	19.05
8150	3913	61.0	18.60
8153	3911	61.1	18.60
8156	3909	60.2	18.35
8160	3906	61.0	18.60
8163	3904	61.1	18.60
8167	3902	60.1	18.30
8171	3900	59.1	18.00
8175	3897	59.5	18.15
8179	3894	58.9	17.95

F 702

8424	3977	85.0	25.90
8427	3979	85.0	25.90
8430	3981	84.0	25.60
8431	3982	83.7	25.50
8429	3984	84.8	25.85
8427	3986	87.4	26.65
8432	3983	83.3	25.40
8433	3982	82.3	25.10
8434	3985	82.0	25.00
8436	3986	81.0	24.70
8438	3988	80.9	24.65
8440	3990	82.2	25.05

F 703

8111	3897	78.5	23.95
8116	3896	77.6	23.65
8120	3895	76.1	23.20
8125	3895	76.6	23.35
8129	3894	75.7	23.05
8134	3894	75.9	23.15

F 704

8448	3965	46.0	14.00
8447	3968	45.3	13.80
8445	3967	43.5	13.25
8443	3966	43.7	13.30
8446	3971	42.5	12.95
8445	3974	44.3	13.50
8444	3977	44.4	13.55
8443	3980	43.5	13.25

F 705

8141	3860	79.9	24.35
8146	3860	79.0	24.10
8150	3859	77.8	23.70

F 706

8492	4024	47.0	14.35
8496	4027	47.6	14.50
8499	4030	47.9	14.60
8503	4033	48.4	14.75
8507	4036	47.9	14.60
8511	4039	47.7	14.55
8516	4040	46.9	14.30
8520	4043	46.6	14.20
8523	4047	47.8	14.55
8524	4046	44.6	13.60
8522	4048	47.6	14.50
8520	4049	46.3	14.10
8519	4051	44.8	13.65
8518	4052	47.8	14.55
8527	4050	47.9	14.60
8529	4055	48.1	14.65
8529	4061	47.1	14.35
8535	4074	47.4	14.45

F 707

8136	3874	77.7	23.70
8138	3871	76.5	23.30
8140	3868	74.4	22.70
8143	3866	73.9	22.50
8146	3865	74.0	22.55
8149	3864	73.9	22.50
8152	3863	74.1	22.60
8156	3862	74.2	22.60
8160	3861	75.5	23.00
8164	3860	76.3	23.25
8169	3859	74.7	22.75
8173	3858	73.6	22.45
8177	3858	73.3	22.35
8181	3858	72.1	22.00
8185	3858	71.0	21.65
8190	3858	70.7	21.55
8194	3858	70.6	21.50
8198	3857	71.1	21.65
8202	3857	71.9	21.90
8207	3857	72.0	21.95
8211	3856	70.9	21.60
8216	3856	71.1	21.65
8221	3856	72.5	22.10
8225	3856	72.6	22.15
8230	3855	73.6	22.45
8233	3857	71.6	21.80
8235	3853	71.9	21.90
8238	3851	71.8	21.90

F 708

8520	4040	44.7	13.60
8522	4042	44.8	13.65
8525	4045	44.7	13.60
8529	4049	44.7	13.60
8532	4053	44.6	13.60
8534	4058	44.5	13.55
8536	4062	44.4	13.55
8537	4067	43.8	13.35
8539	4071	44.0	13.40
8537	4072	45.0	13.70
8540	4077	44.4	13.55
8542	4081	44.9	13.70

F 709

8179	3888	80.3	24.50

F 710

8522	4063	54.3	16.55
8525	4065	53.7	16.35
8528	4069	52.7	16.05
8530	4068	49.3	15.05
8527	4070	53.5	16.30
8525	4071	53.8	16.40
8532	4073	51.3	15.65
8535	4077	48.9	14.90

F 711

8195	3878	92.2	28.10
8199	3878	92.7	28.25
8202	3878	94.3	28.75
8205	3878	94.5	28.80

F 712

8615	4117	40.2	12.25
8619	4118	40.2	12.25
8623	4119	39.3	12.00
8626	4121	39.3	12.00
8629	4123	39.0	11.90
8628	4124	40.4	12.30
8627	4125	40.2	12.25
8626	4126	42.8	13.05
8632	4126	39.7	12.10
8634	4129	40.4	12.30

F 713

8207	3881	99.5	30.35
8207	3877	96.4	29.40
8211	3880	95.3	29.05
8215	3880	96.0	29.25

F 714

8627	4133	42.8	13.05
8629	4136	42.9	13.10
8631	4139	42.7	13.00
8632	4143	42.5	12.95
8633	4147	42.4	12.90
8634	4151	42.2	12.85
8634	4156	41.7	12.70
8635	4160	40.7	12.40
8635	4164	40.3	12.30
8636	4168	40.0	12.20
8635	4172	40.9	12.45
8633	4172	39.5	12.05

F 718

8620	4215	111.1	33.85
8618	42.4	110.4	33.65
8615	4213	110.2	33.60
8614	4215	111.0	33.85
8616	4211	110.0	33.55
8612	4212	110.1	33.55
8609	4210	110.3	33.60
8605	4209	109.4	33.35
8602	4207	108.2	33.00
8598	4206	107.8	32.85
8595	4212	108.4	33.05

F 719

8242	3849	70.0	21.35
8246	3848	69.9	21.30
8250	3847	70.8	21.60
8254	3845	69.3	21.10
8258	3845	68.5	20.90
8262	3844	68.6	20.90
8266	3844	68.2	20.80
8266	3848	68.5	20.90
8266	3852	68.8	20.95
8271	3844	66.8	20.35
8275	3844	67.3	20.50
8379	3844	67.2	20.50
8283	3844	66.3	20.20
8288	3844	67.5	20.55
8293	3844	69.9	21.30
8290	3847	69.2	21.10
8287	3850	70.0	21.35
8296	3841	69.0	21.05
8300	3839	68.7	20.95
8303	3836	68.4	20.85
8306	3834	68.1	20.75
8309	3831	67.6	20.60

8298	3844	68.5	20.90
8302	3844	69.1	21.05
8307	3844	67.5	20.55
8311	3843	66.6	20.30
8313	3840	68.7	20.95
8316	3836	70.3	21.45
8320	3835	68.8	20.95
8324	3835	68.0	20.75
8328	3835	66.0	20.10
8332	3835	63.5	19.35
8336	3834	62.6	19.10
8340	3836	63.4	19.30
8343	3838	64.7	19.75
8345	3839	65.1	19.85

F 720

8673	4298	41.3	12.60
8676	4302	40.0	12.20
8679	4307	40.6	12.35
8683	4311	37.5	11.45
8686	4315	38.0	11.60
8685	4316	37.3	11.35
8683	4317	40.7	12.40
8682	4318	43.0	13.10
8690	4320	37.9	11.55
8691	4325	38.0	11.60
8692	4330	37.6	11.45
8793	4335	34.2	10.40
8695	4340	35.5	1o.80
8697	4345	36.2	11.05
8698	4350	33.5	10.20

F 721

8337	3865	58.1	17.70
8341	3865	58.2	17.75
8345	3865	57.7	17.60
8349	3866	57.8	17.60
8353	3866	57.8	17.60
8358	3866	57.2	17.45
8362	3867	57.1	17.40
8366	3867	57.3	17.45
8370	3867	57.3	17.45
8374	3868	57.6	17.55
8377	3868	57.2	17.45
8378	3864	55.4	16.90
8379	3860	54.9	16.75
8380	3855	53.9	16.45
8382	3851	53.4	16.30
8383	3847	55.2	16.80
8384	3842	55.8	17.00
8385	3838	55.5	16.90
8381	3868	58.6	17.85
8385	3869	59.3	18.05
8389	3869	59.2	18.05
8394	3869	59.4	18.10
8398	3868	58.1	17.70
8402	3866	57.6	17.55
8406	3863	57.0	17.35
8410	3860	56.6	17.25
8415	3857	56.4	17.20
8417	3853	56.0	17.05
8420	3850	55.4	16.90
8422	3846	55.3	16.85
8425	3843	56.5	17.20
8428	3840	57.1	17.40
8432	3839	56.5	17.20
8435	3838	57.0	17.35
8436	3834	56.8	17.30
8437	3829	56.5	17.20
8438	3825	55.6	16.95
8440	3821	54.9	16.75
8441	3817	54.3	16.55
8442	3812	53.7	16.35
8434	3843	54.0	16.45
8433	3848	52.2	15.90
8432	3853	54.8	16.70
8435	3853	54.0	16.45
8439	3851	54.2	16.50
8443	3850	54.2	16.50
8447	3849	54.3	16.55
8452	3848	54.4	16.60
8456	3847	55.8	17.00
8460	3846	56.2	17.15
8465	3845	56.0	17.05
8469	3845	55.6	16.95
8473	3846	55.5	16.90
8477	3846	55.0	16.75
8481	3847	54.1	16.50
8485	3847	53.9	16.45
8489	3847	53.7	16.35
8493	3848	52.9	16.10
8495	3848	53.0	16.15
8497	3844	52.7	16.05
8499	3840	53.9	16.45
8501	3836	54.5	16.60
8503	3832	54.9	16.75
8505	3828	55.4	16.90
8498	3848	52.5	16.00
8502	3848	53.1	16.20
8507	3848	53.8	16.40
8511	3848	54.5	16.60
8515	3848	54.5	16.60
8519	3848	54.4	16.60
8523	3850	54.0	16.45
8526	3852	53.9	16.45
8530	3853	53.9	16.45
8532	3850	51.0	15.55
8534	3846	51.2	15.60

8536	3843	52.8	16.10
8539	3840	52.6	16.05
8541	3837	53.4	16.30
8534	3856	54.1	16.50
8536	3859	54.2	16.50
8539	3862	53.8	16.40
8542	3865	53.7	16.35
8544	3868	53.4	16.30
8547	3871	53.3	16.25
8550	3874	52.9	16.10
8552	3878	52.0	15.85
8555	3881	51.5	15.70
8558	3884	51.7	15.75
8560	3887	51.7	15.75
8563	3889	52.5	16.00
8565	3892	51.8	15.80
8557	3896	51.6	15.75
8556	3901	51.3	15.65
8554	3905	51.7	15.75
8551	3907	50.1	15.25
8548	3909	50.0	15.25
8546	3912	51.3	15.65
8543	3915	51.5	15.70

<u>F 722</u>

8663	4283	33.1	10.10
8668	4286	32.9	10.05
8671	4291	33.4	10.20
8674	4296	32.9	10.05
8677	4301	32.5	9.90

<u>F 725</u>

8368	3819	75.3	22.95
8372	3817	75.2	22.90
8376	3816	76.4	23.30
8380	3814	74.6	22.75
8371	3814	75.6	23.05
8375	3814	76.3	23.25

<u>F 726</u>

8719	4415	97.1	29.60
8726	4418	101.2	30.85
8731	4420	100.8	30.70
8738	4420	97.5	29.70
8745	4420	97.4	29.70
8752	4421	99.2	30.25
8756	4421	102.8	31.35
8760	4421	104.0	31.70
8764	4422	103.6	31.60
8767	4423	103.8	31.65
8765	4427	101.9	31.05
8763	4431	101.1	30.80
8762	4435	101.2	30.85
8760	4439	99.9	30.45
8758	4443	97.0	29.55
8770	4426	103.5	31.55
8772	4430	103.4	31.50
8774	4433	104.1	31.75
8776	4436	103.2	31.45

<u>F 727</u>

8489	3808	68.0	20.75
8492	3808	67.3	20.50
8497	3808	64.9	19.80
8501	3808	65.9	20.10
8506	3808	65.7	20.05

<u>F 728</u>

8815	4493	32.6	9.95
8818	4498	32.0	9.75
8821	4501	32.0	9.75
8823	4505	32.0	9.75
8825	4508	32.0	9.75
8827	4511	32.2	9.80
8829	4514	32.3	9.85
8831	4518	32.0	9.75
8832	4521	33.4	10.20
8834	4524	34.0	10.35
8836	4528	33.7	10.25
8838	4531	34.2	10.40
8840	4534	34.5	10.50
8842	4533	33.6	10.25
8837	4535	33.9	10.35
8843	4536	34.8	10.60
8846	4539	35.0	10.65
8849	4541	35.2	10.75

<u>F 729</u>

8511	3803	63.0	19.20
8510	3807	62.2	18.95
8509	3811	59.1	18.00

<u>F 730</u>

8824	4515	42.5	12.95
8825	4518	42.5	12.95
8826	4521	41.9	12.75
8827	4524	41.7	12.70
8828	4527	42.1	12.85
8831	4529	42.3	12.90
8835	4534	41.9	12.75
8839	4540	39.2	11.95
8841	4543	38.8	11.85
8843	4545	38.1	11.60

F 731

8432	3876	53.1	16.20
8434	3874	53.1	16.20
8439	3870	53.1	16.20
8443	3867	53.2	16.20
8448	3864	51.7	15.75
8452	3861	52.9	16.10
8456	3858	54.3	16.55
8455	3852	52.3	15.95
8454	3850	51.0	15.55
8453	3849	54.1	16.50
8461	3855	52.9	16.10
8466	3852	52.5	16.00
8472	3850	51.8	15.80
8477	3848	51.0	15.55

F 734

8852	4543	26.1	7.95
8853	4544	25.1	7.65
8854	4546	25.9	7.90
8855	4547	26.2	8.00

F 735

8573	3887	47.6	14.50
8573	3891	46.3	14.10
8572	3894	46.7	14.25
8571	3897	46.7	14.25

F 736

8857	4552	30.0	9.15
8860	4552	30.0	9.15
8863	4554	30.7	9.35
8866	4556	30.7	9.35
8865	4557	30.2	9.20
8864	4558	29.7	9.05
8869	4558	30.8	9.40
8872	4560	29.4	8.95

F 738

8865	4563	88.8	27.05
8869	4564	86.9	26.50
8869	4565	86.9	26.50
8869	4567	86.5	26.35
8868	4568	86.9	26.50
8868	4570	88.0	26.80
8868	4571	90.6	27.60
8872	4565	88.9	27.10
8876	4566	87.3	26.60
8879	4567	87.2	26.60
8883	4568	87.0	26.50
8887	4569	86.4	26.35
8890	4570	85.7	26.10
8893	4571	85.3	26.00
8897	4573	84.0	25.60
8898	4570	85.1	25.95
8896	4575	84.4	25.75
8894	4576	83.7	25.50
8893	4578	84.4	25.75
8900	4574	82.4	25.10
8902	4575	81.8	24.95
8907	4576	82.9	25.25
8909	4578	83.6	25.50
8912	4580	82.5	25.15
8912	4579	81.9	24.95
8910	4582	82.8	25.25
8909	4585	81.4	24.80
8907	4588	79.4	24.20
8906	4590	79.0	24.10
8904	4593	79.5	24.25
8914	4582	81.5	24.85
8916	4584	80.0	24.40
8918	4587	78.9	24.05
8921	4589	78.5	23.95
8923	4592	77.5	23.60
8925	4594	75.9	23.15
8928	4592	76.0	23.15
8922	4596	74.4	22.70
8920	4598	74.5	22.70
8917	4599	74.9	22.85
8915	4601	73.4	22.35
8913	4603	73.4	22.35
8910	4605	72.6	22.15
8908	4607	74.3	22.65
8926	4597	75.1	22.90
8928	4600	74.2	22.60

F 739

8556	3953	64.0	19.50
8553	3954	63.4	19.30
8548	3955	62.5	19.05
8543	3956	61.8	18.85
8538	3957	61.7	18.80
8533	3958	61.6	18.80
8528	3960	61.7	18.80
8534	3955	62.3	19.00
8536	3951	62.9	19.15
8538	3948	63.0	19.20
8539	3943	63.7	19.40
8541	3939	63.8	19.45
8542	3935	64.5	19.65
8543	3931	65.1	19.85

8546	3928	67.9	20.70
8542	3928	66.9	20.40
8538	3928	67.6	20.60

8535	3928	65.1	19.85
8531	3929	63.8	19.45
8526	3929	61.3	18.70
8522	3930	61.1	18.60
8520	3935	61.5	18.75
8519	3940	62.1	18.95

8518	3945	63.2	19.25
8517	3950	62.5	19.05
8516	3955	62.6	19.10
8515	3959	62.6	19.10
8514	3962	61.2	18.65
8513	3966	61.3	18.70
8515	3968	60.9	18.55
8512	3970	59.7	18.20
8509	3972	59.7	18.20
8506	3974	59.5	18.15

F 740

8803	4581	120.7	36.80
8806	4576	121.1	36.90
8808	4573	119.7	36.50
8811	4574	120.1	36.60
8814	4575	120.2	36.65
8818	4576	119.9	36.55
8822	4577	120.0	36.60
8825	4579	119.9	36.55
8828	4580	121.3	36.65
8831	4582	120.0	36.60
8835	4583	119.4	36.40
8839	4584	118.2	36.05
8843	4586	117.0	35.65
8847	4587	115.7	35.25
8846	4589	114.0	34.75
8845	4592	114.0	34.75
8851	4588	114.0	34.75
8854	4590	111.5	34.00
8858	4591	110.8	33.75
8862	4592	109.0	33.20
8866	4593	107.1	32.65
8865	4594	106.5	32.45
8865	4595	106.4	32.45
8864	4596	106.8	32.55
8865	4592	107.0	32.60
8866	4591	105.8	32.25
8869	4595	105.2	32.05
8872	4597	103.2	31.45
8876	4598	102.8	31.35
8880	4599	100.4	30.60
8883	4601	98.3	29.95
8887	4603	97.0	29.55

F 741

8480	3963	59.2	18.05
8481	3966	59.6	18.15
8482	3970	59.5	18.15
8482	3974	59.5	18.15
8484	3973	57.7	17.60
8486	3971	57.1	17.40
8487	3970	59.1	18.00
8481	3978	58.9	17.95

F 742

8802	4598	143.4	43.70
8806	4597	145.9	44.45
8809	4598	144.3	44.00
8813	4599	141.7	43.20
8818	4600	141.8	43.20
8818	4597	139.4	42.50
8818	4602	140.1	42.70
8817	4603	140.4	42.80
8817	4605	141.2	43.05
8821	4603	138.4	42.20
8824	4604	136.1	41.50
8829	4606	133.0	40.55
8833	4607	130.4	39.75
8837	4608	127.7	38.90
8840	4610	124.6	38.00
8842	4611	121.9	37.15
8845	4603	121.6	37.05
8848	4604	119.6	36.45
8851	4606	119.2	36.35
8854	4607	119.2	36.35

F 743

8495	3983	56.4	17.20
8490	3985	56.8	17.30
8494	3988	57.1	17.40
8494	3992	57.5	17.55

F 744

8867	4586	99.2	30.25
8866	4588	100.0	30.50
8869	4589	100.1	30.50
8872	4590	99.9	30.45
8875	4592	100.1	30.50
8877	4593	97.1	29.60

F 745

8500	3973	54.0	16.45
8495	3975	53.8	16.40
8490	3978	53.1	16.20
8486	3982	52.5	16.00
8482	3985	50.8	15.50
8478	3987	48.7	14.85

F 746

8924	4578	34.7	10.55
8927	4579	31.6	9.60

8932	4580	29.8	9.10
8936	4582	30.6	9.30
8941	4585	31.3	9.55
8945	4587	33.2	10.10
8948	4589	33.7	10.25
8953	4593	34.4	10.50
8949	4594	33.9	10.35
8945	4596	31.7	9.65
8940	4597	31.4	9.55
8936	4598	35.1	10.70
8955	4597	33.8	10.30
8955	4601	34.9	10.65
8950	4608	32.2	9.80
8946	4610	34.3	10.45
8941	4614	31.0	9.45
8939	4618	30.0	9.15
8928	4583	36.0	10.95
8932	4590	35.7	10.90
8936	4596	35.6	10.85
8938	4604	34.9	10.65
8939	4609	34.3	10.45

F 747

8473	3956	50.5	15.40

F 748

8952	4586	28.8	8.80
8956	4590	28.5	8.70
8958	4595	27.8	8.45
8958	4600	27.1	8.25

F 750

8913	4654	37.5	11.40
8912	4658	36.7	11.20
8910	4663	36.1	11.00
8908	4667	35.1	10.70
8906	4671	33.6	10.25
8904	4674	33.9	10.30
8902	4677	33.7	10.25
8901	4679	36.1	11.00

F 751

8459	3972	45.8	13.95
8459	3977	45.2	13.80
8460	3981	45.7	13.95
8462	3985	46.1	14.05
8465	3989	45.9	14.00
8463	3991	45.0	13.70
8468	3992	45.0	13.70
8472	3994	44.9	13.70
8476	3996	45.6	13.90
8480	3998	45.9	14.00
8483	4000	45.9	14.00
8487	4002	45.7	13.95

F 752

9012	4778	22.2	6.75
9017	4778	22.3	6.80
9022	4778	21.9	6.70
9029	4778	21.4	6.50
9033	4778	22.2	6.75
9034	4781	23.8	7.25
9035	4784	26.3	8.00
9036	4787	27.6	8.40
9038	4778	22.0	6.70
9043	4778	22.7	6.90
9048	4778	23.0	7.00
9052	4780	23.2	7.05
9057	4782	23.4	7.15
9061	4785	23.3	7.10
9059	4788	24.0	7.30
9057	4790	23.5	7.15
9055	4792	26.6	8.10
9064	4788	24.8	7.55
9066	4792	23.7	7.20
9068	4796	23.9	7.30
9070	4801	24.5	7.45

F 753

8483	3991	52.6	16.05
8485	3994	52.9	16.10
8488	3997	50.7	15.45
8492	4000	51.2	15.60

F 754

9053	4806	60.6	18.45
9053	4810	62.1	18.95
9053	4814	62.1	18.95

F 756

9077	4818	20.8	6.35
9077	4822	21.8	6.65
9077	4827	21.5	6.55
9077	4831	20.9	6.35
9077	4835	20.9	6.35
9076	4839	21.0	6.40
9076	4844	20.5	6.25
9075	4848	20.3	6.20
9072	4860	21.1	6.45
9071	4864	21.4	6.50
9070	4868	21.5	6.55
9069	4872	21.4	6.50

9067	4876	21.6	6.60
9066	4880	21.0	6.40
9065	4884	20.6	6.30
9064	4888	20.1	6.15

F 758

9073	4842	24.8	7.55
9073	4846	25.3	7.70
9072	4849	25.2	7.70
9071	4853	24.4	7.45
9070	4857	24.8	7.55
9068	4859	25.3	7.70

F 760

9072	4807	24.1	7.35
9072	4811	23.0	7.00
9073	4815	22.6	6.90
9073	4819	22.6	6.90
9073	4823	22.3	6.80

F 761

8556	4082	67.6	20.60
8560	4082	67.7	20.65
8564	4083	66.7	20.35
8568	4084	65.1	19.85
8572	4085	63.2	19.25
8576	4086	61.7	18.80
8580	4087	61.4	18.70
8584	4088	61.0	18.60

F 762

9225	4958	27.0	8.25
9228	4955	24.7	7.55
9231	4953	23.4	7.15
9235	4951	20.7	6.30
9239	4949	20.4	6.20
9242	4947	20.4	6.20
9246	4945	20.8	6.35
9250	4946	20.8	6.35
9254	4948	20.4	6.20
9257	4949	22.2	6.75
9261	4950	21.4	6.50
9263	4953	22.3	6.80
9264	4956	22.1	6.75
9265	4960	22.0	6.70
9266	4965	21.4	6.50
9267	4970	21.1	6.45

F 763

8556	4088	44.1	13.45
8559	4091	43.8	13.35
8561	4095	43.1	13.15
8564	4097	43.2	13.15
8567	4099	43.6	13.30
8571	4101	44.3	13.50
8575	4103	43.8	13.35
8580	4104	43.5	13.25
8585	4104	44.3	13.50
8589	4104	44.8	13.65
8593	4105	45.3	13.80
8598	4105	44.4	13.55

F 764

9234	4959	27.3	8.30
9238	4961	27.5	8.40
9241	4962	26.9	8.20
9245	4964	26.6	8.10
9249	4966	26.4	8.05
9252	4968	26.4	8.05
9255	4970	26.3	8.00
9258	4973	24.7	7.55
9261	4975	23.9	7.30

F 766

9238	4974	42.8	13.05

F 767

8643	4188	41.7	12.70
8643	4192	41.6	12.70
8643	4196	41.7	12.70
8643	4200	42.3	12.90
8644	4204	42.0	12.80
8645	4208	42.0	12.80
8649	4207	42.5	12.95
8641	4208	39.7	12.10
8636	4209	36.8	11.20
8646	4212	41.7	12.70
8646	4216	41.5	12.65
8647	4220	41.7	12.70
8648	4223	42.0	12.80
8649	4227	42.4	12.90
8650	4231	42.6	13.00
8651	4234	42.8	13.05
8652	4238	42.8	13.05
8650	4239	41.5	12.65
8655	4237	41.4	12.60
8658	4237	41.8	12.75
8652	4242	40.6	12.35
8653	4246	39.8	12.15
8654	4250	39.7	12.10
8655	4254	39.6	12.05
8657	4258	39.6	12.05

8659	4261	39.4	12.00
8660	4264	38.8	11.85
8662	4267	38.9	11.85
8665	4270	39.2	11.95
8668	4272	39.7	12.10
8671	4275	39.0	11.90
8674	4277	40.5	12.35

F 768

9238	4981	70.1	21.35
9240	4984	73.5	22.40
9242	4988	72.0	21.95
9244	4992	70.2	21.40

F 769

8679	4263	123.0	37.50
8682	4265	121.0	36.90
8685	4267	121.9	37.15
8689	4268	119.9	36.55
8693	4268	116.8	35.60

8673	4250	115.1	35.10
8675	4253	115.6	35.25
8678	4255	117.8	35.90
8682	4257	117.9	35.95
8680	4261	119.6	36.45
8684	4254	119.0	36.25
8685	4251	123.0	37.50
8686	4259	117.2	35.70
8689	4261	115.2	35.10
8693	4262	113.2	34.50
8697	4263	112.2	34.20
8702	4263	110.7	33.75
8706	4264	111.3	33.90
8711	4265	111.2	33.90

F 770

9220	4980	86.5	26.35
9222	4984	85.9	26.20
9225	4987	86.5	26.35
9227	4990	86.0	26.20

F 771

8724	4286	86.6	26.40
8720	4284	87.4	26.65
8716	4282	87.7	26.75
8712	4280	87.9	26.80
8708	4279	86.9	26.50
8709	4277	84.8	25.85
8710	4274	84.1	25.65
8711	4272	87.3	26.60
8704	4278	84.5	25.75

8700	4277	82.7	25.20
8695	4277	81.9	24.95
8691	4279	80.4	24.50

F 773

8707	4288	53.7	16.35
8702	4288	55.7	17.00
8702	4285	57.3	17.45
8697	4287	54.8	16.70
8693	4288	54.7	16.65
8691	4290	54.6	16.65

F 775

8713	4297	36.0	10.95
8708	4296	35.5	10.80
8703	4296	36.2	11.05
8700	4298	37.2	11.35
8698	4296	38.2	11.65

F 776

9330	5057	23.6	7.20
9331	5060	22.1	6.75
9332	5065	21.8	6.65
9332	5070	22.5	6.85
9331	5075	22.6	6.90
9330	5075	21.9	6.70
9329	5075	21.0	6.40
9328	5075	21.7	6.60
9333	5075	22.2	6.75
9334	5075	20.8	6.35
9336	5075	16.0	4.90
9331	5079	22.5	6.85
9331	5084	21.9	6.70
9331	5089	21.7	6.60
9330	5094	21.1	6.45
9330	5099	22.7	6.90

F 777

8725	4304	37.8	11.50
8720	4304	40.2	12.25
8715	4303	40.5	12.35
8710	4303	41.3	12.60
8705	4302	42.6	13.00
8705	4306	42.4	12.90

F 778

9334	5057	15.0	4.55

F 779

8716	4312	100.8	30.70

8712	4312	99.2	30.25
8718	4315	100.2	30.55
8721	4317	100.1	30.50
8725	4317	98.9	30.15
8728	4316	99.5	30.35
8724	4320	99.9	30.45
8726	4322	96.7	29.45
8728	4325	96.6	29.45
8730	4328	95.9	29.25
8732	4332	96.7	29.45

F 780

9339	5072	16.8	5.10
9339	5077	16.1	4.90
9339	5082	15.3	4.65
9338	5087	15.1	4.60
9338	5091	15.2	4.65
9337	5096	15.2	4.65
9335	5100	14.9	4.55

F 781

8733	4312	99.2	30.25
8735	4316	97.1	29.60
8736	4320	98.3	29.95
8737	4324	99.3	30.25
8738	4328	100.5	30.65
8739	4332	100.7	30.70
8741	4336	99.6	30.35
8745	4335	100.7	30.70
8750	4334	100.8	30.70
8754	4333	102.5	31.25
8737	4337	99.3	30.25
8741	4339	100.2	30.55

F 783

8708	4312	94.7	28.85
8709	4315	94.9	28.95
8709	4320	94.2	28.70
8709	4323	93.8	28.60
8710	4326	93.2	28.40
8712	4328	92.4	28.15
8716	4332	91.6	27.90
8719	4334	87.8	26.75
8721	4337	86.2	26.25
8724	4340	84.5	25.75
8726	4343	83.4	25.40

F 785

8724	4346	78.3	23.85
8726	4345	79.5	24.25
8729	4343	82.2	25.05
8726	4349	76.4	23.30
8728	4352	74.6	22.75
8731	4354	75.8	23.10

F 786

9327	5107	19.6	5.95
9327	5108	18.8	5.75
9325	5112	19.2	5.85
9323	5116	18.9	5.75
9321	5120	19.2	5.85
9319	5125	20.0	6.10

F 787

8706	4337	33.9	10.35
8708	4341	34.0	10.35
8710	4345	32.4	9.90

F 789

8712	4336	42.9	13.10
8709	4339	41.3	12.60
8708	4344	40.2	12.25
8725	4357	40.6	12.35
8747	4370	43.1	13.15

F 790

9302	5127	47.3	14.40
9300	5130	47.3	14.40
9299	5133	46.7	14.25
9298	5136	42.9	13.10
9298	5140	45.6	13.90

F 791

8713	4348	38.7	11.80
8714	4353	37.9	11.55
8716	4357	38.2	11.65
8721	4361	38.2	11.65
8723	4359	39.2	11.95
8725	4357	40.6	12.35
8727	4356	42.6	13.00
8726	4364	38.4	11.70
8730	4367	38.1	11.60
8735	4369	39.1	11.90
8738	4370	39.0	11.90
8742	4371	39.2	11.95
8747	4372	38.3	11.65

F 792

9310	5138	28.6	8.70

9309	5143	29.2	8.90
9309	5148	28.0	8.55
9310	5153	27.8	8.45
9312	5157	26.5	8.10
9313	5160	27.0	8.25

F 793

8847	4498	94.9L	28.95
8848	4502	97.1L	29.60
8850	4508	96.1L	29.30
8846	4512	96.2L	29.30
8855	4503	96.2L	29.30
8860	4499	94.2L	28.70
8862	4497	93.7L	28.55
8853	4512	95.8L	29.20
8858	4515	95.4L	29.10
8862	4519	94.9L	28.95
8867	4524	92.4L	28.15
8872	4528	92.5L	28.20
8875	4525	92.1L	28.05
8877	4522	92.3L	28.15
8879	4518	91.1L	27.75
8882	4515	89.4L	27.25
8885	4512	90.1L	27.45
8878	4529	93.1L	28.40
8884	4530	91.5L	27.90

F 794

8964	5023	152.8	46.55
8964	5019	151.4	46.15
8965	5015	151.6	46.20
8966	5012	151.4	46.15
8968	5024	151.5	46.20
8972	5026	150.7	45.95
8976	5027	150.2	45.80
8980	5028	150.2	45.80
8984	5029	150.9	46.00
8982	5033	150.3	45.80
8981	5037	151.0	46.00
8979	5041	150.5	45.85
8978	5045	150.9	46.00
8976	5048	150.3	45.80
8987	5032	150.8	45.95
8990	5035	150.4	45.85
8993	5039	149.9	45.70
8997	5043	149.4	45.55
9001	5046	149.4	45.55
9003	5049	149.3	45.50
9006	5052	149.4	45.55
9010	5055	149.4	45.55
9013	5058	149.9	45.70
9017	5061	150.6	45.90
9020	5064	151.7	46.25
9023	5067	152.7	46.55
9026	5070	152.8	46.55
9029	5073	152.9	46.60
9032	5076	153.2	46.70
9035	5080	153.8	46.90
9039	5083	154.2	47.00
9042	5086	155.8	47.50
9045	5089	156.8	47.80
9048	5093	157.4	48.00
9051	5096	157.0	47.85
9053	5098	156.3	47.65
9057	5099	155.9	47.50
9061	5099	154.3	47.05
9066	5100	152.3	46.40
9070	5101	151.4	46.15
9074	5102	151.0	46.00
9079	5103	150.9	46.00

F 795a

8868	4536	80.6L	24.55
8872	4539	79.9L	24.35
8877	4541	79.5L	24.25
8878	4539	78.3L	23.85

F 795b

8879	4542	62.8L	19.15
8884	4543	62.2L	18.95

F 796

9234	5185	130.6	39.80
9236	5188	131.8	40.15
9240	5190	130.6	39.80
9245	5192	130.5	39.80
9243	5197	132.2	40.30
9242	5201	129.6	39.50
9241	5205	130.9	39.90
9241	5210	131.5	40.10
9240	5215	131.6	40.10
9240	5219	133.2	40.60
9260	5200	130.8	39.85
9265	5202	132.4	40.35
9267	5205	134.1	40.85
9267	5210	134.2	40.90
9268	5240	130.8	39.85
9267	5245	133.3	40.65
9271	5247	131.9	40.20
9276	5248	130.6	39.80
9281	5249	129.2	39.40
9285	5250	128.5	39.15
9290	5250	127.8	38.95
9294	5251	125.9	38.35
9319	5254	126.4	38.55

9324	5253	126.0	38.40
9329	5253	125.3	38.20
9329	5248	122.1	37.20
9329	5242	119.9	36.55
9328	5258	124.3	37.90
9328	5263	123.9	37.75
9327	5267	124.2	37.85
9327	5272	126.0	38.40
9326	5276	126.2	38.45
9326	5280	127.5	38.85
9325	5285	128.5	39.15
9325	5289	128.3	39.10
9334	5253	126.0	38.40
9340	5253	124.3	37.90
9345	5254	123.5	37.65
9350	5255	124.4	37.90
9356	5255	123.2	37.55
9361	5254	120.1	36.60
9366	5252	120.4	36.70
9373	5252	118.6	36.15
9375	5248	120.9	36.85
9379	5247	120.5	36.75
9383	5245	118.8	36.20
9386	5243	118.3	36.05
9390	5241	116.7	35.55
9394	5240	115.2	35.10
9398	5239	113.7	34.65
9402	5238	113.2	34.50
9406	5237	112.8	34.40
9411	5236	110.4	33.65
9415	5236	108.9	33.20
9420	5236	109.6	33.40
9424	5237	107.2	32.65
9428	5238	106.7	32.50
9431	5240	105.9	32.30
9435	5242	105.2	32.05
9440	5243	105.1	32.05
9444	5244	105.0	32.00
9449	5245	104.2	31.75

F 797

8867	4540	28.7L	8.75
8871	4544	27.3L	8.30
8875	4548	26.7L	8.15
8879	4549	25.9L	7.90

F 798

9485	5256	99.2	30.25
9490	5255	97.9	29.85
9495	5254	97.8	29.80
9503	5249	95.2	29.00
9508	5248	93.6	28.55
9513	5247	93.5	28.50
9518	5247	93.6	28.55
9522	5248	92.6	28.20

F 799

8871	4541	36.4L	11.10
8875	4545	34.4L	10.50
8880	4547	34.0L	10.35
8885	4549	34.8L	10.60
8885	4547	35.3L	10.75
8886	4546	38.6L	11.75
8891	4550	35.6L	10.85
8893	4550	35.7L	10.90
8898	4551	35.1L	10.70
8903	4552	35.8L	10.90
8908	4554	36.0L	10.95
8913	4555	35.5L	10.80
8918	4557	34.6L	10.55
8923	4558	34.2L	10.40
8928	4559	32.2L	9.80

F 801

8894	4537	63.7L	19.40
8898	4539	64.9L	19.80
8903	4541	65.3L	19.90
8905	4537	64.4L	19.65
8907	4533	62.9L	19.15
8911	4529	62.7L	19.10
8915	4525	63.0L	19.20
8901	4544	65.5L	19.95
8908	4546	66.8L	20.35
8913	4547	65.8L	20.05
8918	4548	65.9L	20.10
8923	4550	66.4L	20.25
8928	4551	62.1L	18.95

F 802

9454	5234	54.1	16.50
9458	5234	50.4	15.35
9462	5234	48.1	14.65
9466	5234	45.6	13.90
9470	5234	42.0	12.80
9472	5233	41.9	12.75
9475	5233	39.9	12.15
9478	5233	38.9	11.85
9483	5233	37.2	11.35
9486	5232	37.5	11.45

9490	5232	37.1	11.30
9493	5232	37.9	11.55
9496	5233	37.4	11.40
9499	5235	37.3	11.35
9503	5237	37.3	11.35

F 803

8936	4541	57.4L	17.50
8939	4543	55.2L	16.80
8941	4546	53.7L	16.35
8943	4548	53.3L	16.25

F 804

9444	5228	15.4	4.70
9448	5228	15.6	4.75
9452	5228	15.5	4.70
9456	5228	15.8	4.80
9459	5227	15.3	4.65
9463	5227	15.7	4.80
9467	5227	15.7	4.80
9471	5227	15.6	4.75
9434	5224	15.5	4.70
9438	5223	16.4	5.00
9443	5222	15.0	4.55

F 805

8947	4554	44.4L	13.55
8948	4557	43.7L	13.30
8949	4559	43.2L	13.15

F 806

9475	5224	15.9	4.85
9480	5223	17.7	5.40
9485	5223	17.7	5.40
9489	5221	17.7	5.40
9493	5220	18.2	5.55
9493	5225	18.1	5.50
9493	5216	13.8	4.20
9492	5212	14.4	4.40
9498	5220	17.8	5.45
9502	5223	17.0	5.20
9506	5225	16.6	5.05
9511	5224	16.4	5.00
9516	5223	16.2	4.95
9521	5222	16.0	4.90
9525	5222	16.5	5.05
9530	5221	15.9	4.85
9535	5223	15.1	4.60
9535	5219	16.2	4.95
9534	5215	16.4	5.00
9533	5210	16.8	5.10
9532	5206	12.7	3.85
9535	5220	15.3	4.65
9540	5219	15.1	4.60
9545	5218	14.8	4.50
9550	5217	13.9	4.25
9554	5215	13.3	4.05
9558	5214	13.4	4.10
9563	5214	13.5	4.10
9565	5217	13.7	4.20
9564	5212	14.2	4.35
9563	5207	15.7	4.80
9562	5202	14.2	4.35
9562	5200	12.7	3.85
9568	5212	13.4	4.10
9573	5210	13.3	4.05
9578	5209	13.1	4.00
9583	5208	12.7	3.85
9588	5209	12.9	3.95
9589	5210	13.5	4.10
9594	5213	13.8	4.20
9597	5216	15.5	4.70
9600	5219	17.0	5.20
9603	5215	16.0	4.90
9607	5212	16.2	4.95
9610	5208	16.1	4.90
9613	5205	14.8	4.50
9618	5202	12.2	3.70
9617	5200	13.8	4.20
9622	5198	13.5	4.10
9625	5195	12.8	3.90
9628	5192	13.3	4.05
9634	5190	13.6	4.15
9639	5188	13.7	4.20
9644	5187	13.5	4.10
9649	5185	12.6	3.85
9654	5184	12.1	3.70
9656	5189	12.2	3.70
9658	5195	8.6	2.60
9653	5180	12.1	3.70
9651	5176	8.5	2.60
9659	5183	11.7	3.55
9664	5183	11.1	3.40
9669	5183	10.0	3.05
9674	5183	9.9	3.00
9679	5183	11.6	3.55
9684	5183	12.1	3.70
9688	5182	11.6	3.55
9693	5182	11.3	3.45
9698	5181	10.6	3.25
9702	5181	9.4	2.85
9706	5180	9.3	2.85

F 807

8930	4552	57.1L	17.40
8932	4552	55.9L	17.05
8935	4553	52.9L	16.10
8939	4553	52.4L	15.95

F 808

9472	5222	14.8	4.50
9475	5221	14.8	4.50
9478	5220	14.4	4.40
9482	5218	14.9	4.55
9486	5217	14.6	4.45
9489	5216	14.1	4.30
9493	5215	13.8	4.20

F 809

8933	4671	42.0	12.80
8932	4674	40.9	12.45
8931	4678	40.5	12.30
8930	4682	41.0	12.50

F 810

9544	5249	71.2	21.70
9544	5248	69.5	21.20

F 811

8941	4634	25.4	7.75
8938	4636	24.9	7.60
8935	4638	25.1	7.65
8938	4642	27.6	8.40
8937	4645	27.5	8.35
8935	4649	27.8	8.50
8932	4653	28.0	8.55
8930	4656	28.7	8.75
8929	4660	29.3	8.95
8940	4645	32.2	9.80
8938	4648	31.9	9.70
8936	4651	32.1	9.75
8934	4655	32.3	9.85
8933	4658	32.7	9.95

F 813

8986	4613	102.9	31.35
8983	4615	104.7	31.90
8980	4617	105.5	32.15
8977	4620	104.8	31.95
8974	4624	103.6	31.60
8971	4627	103.2	31.45
8968	4629	102.6	31.30
8965	4633	102.4	31.20
8962	4637	101.8	31.05
8960	4640	102.0	31.10
8960	4645	100.4	30.60
8958	4649	100.3	30.60
8956	4653	101.5	30.95
8955	4656	101.9	31.05
8956	4659	107.2	32.65
8957	4664	107.9	32.90
8958	4668	108.4	33.05
8960	4673	107.8	32.85
8962	4670	108.1	32.95
8964	4667	107.9	32.85
8966	4664	107.3	32.70
8968	4661	106.5	32.45
8970	4658	106.4	32.45
8972	4655	107.3	32.70
8974	4652	108.8	33.15
8976	4650	114.2	34.80

F 814

9553	5242	59.2	18.05
9554	5238	56.7	17.30
9556	5236	54.7	16.65
9560	5235	55.6	16.95
9564	5234	56.8	17.30
9567	5231	57.8	17.60
9571	5228	58.0	17.70
9576	5225	56.7	17.30
9580	5223	55.6	16.95
9584	5221	54.5	16.60
9588	5219	57.4	17.50
9586	5216	56.5	17.20

F 815

8957	4685	77.2	23.55
8965	4690	76.3	23.25
8968	4693	75.9	23.15
8971	4696	76.7	23.35
8974	4698	75.4	22.95
8977	4701	74.7	22.75
8979	4704	73.0	22.25
8980	4702	72.8	22.20
8981	4701	74.2	22.60
8981	4700	75.5	23.00
8982	4700	76.9	23.45
8978	4705	72.7	22.15
8977	4706	72.1	22.00
8976	4707	70.9	21.60
8975	4708	68.9	21.00
8982	4706	70.2	21.40
8985	4708	69.5	21.20
8988	4711	66.7	20.30
8991	4714	64.8	19.75
8994	4716	62.5	19.05
8997	4718	57.9	17.65
8998	4721	57.2	17.45
9001	4728	50.8	15.50
9005	4729	49.6	15.10
9008	4730	48.6	14.80
9012	4732	47.0	14.35
9015	4734	45.2	13.80

9019	4736	43.5	13.25
9023	4738	42.6	13.00
9026	4742	42.8	13.05
9027	4740	41.7	12.70
9030	4742	40.0	12.20

F 816

9577	5260	18.1	5.50
9581	5258	17.1	5.20
9584	5255	16.7	5.10
9588	5253	16.3	4.95
9592	5250	15.8	4.80
9595	5248	15.1	4.60
9599	5245	14.7	4.50
9602	5242	13.8	4.20
9606	5239	13.2	4.00
9610	5238	13.5	4.10
9614	5236	13.4	4.10
9618	5235	13.1	4.00
9623	5234	13.0	3.95
9624	5229	12.6	3.85
9625	5225	10.2	3.10
9627	5221	9.3	2.85
9629	5218	8.2	2.50
9631	5214	8.7	2.65
9635	5212	7.8	2.40
9639	5210	7.4	2.25
9643	5209	8.5	2.60
9648	5208	7.8	2.40
9652	5208	7.7	2.35
9656	5207	6.5	2.00
9661	5206	6.1	1.85
9665	5205	5.4	1.65
9669	5204	5.7	1.75
9673	5204	5.8	1.75
9678	5203	5.1	1.55
9682	5202	4.1	1.25

F 817

8935	4675	47.5	14.50
8935	4679	46.3	14.10
8934	4683	48.3	14.70
8935	4687	49.1	14.95
8935	4691	50.2	15.30
8937	4695	49.0	14.90
8939	4698	46.7	14.20
8941	4701	44.9	13.65
8943	4705	45.3	13.80
8944	4707	45.6	13.90
8945	4711	46.6	14.20
8947	4714	45.0	13.70

F 818

9637	5235	52.1	15.90
9641	5236	50.2	15.30
9645	5237	50.3	15.35
9647	5237	48.9	14.90
9648	5238	48.6	14.80
9652	5238	48.7	14.85
9656	5238	49.0	14.95
9660	5239	48.0	14.65
9664	5239	46.6	14.20
9668	5239	47.3	14.40
9672	5240	47.5	14.50
9678	5240	46.3	14.10
9678	5242	51.0	15.55
9678	5236	46.6	14.20
9678	5232	49.0	14.95
9679	5228	46.9	14.30
9679	5224	42.3	12.90
9679	5220	46.1	14.05
9680	5217	43.2	13.15
9680	5214	42.6	13.00
9682	5241	47.2	14.40
9686	5241	46.0	14.00
9690	5242	44.6	13.60
9694	5242	43.8	13.35
9698	5241	42.9	13.10

F 819

8921	4710	46.4	14.15
8923	4713	47.2	14.35
8922	4716	46.8	14.25
8920	4718	45.9	14.00
8925	4710	46.7	14.20
8928	4708	46.4	14.15
8926	4715	46.4	14.10
8929	4717	46.2	14.10
8931	4719	45.9	14.00
8933	4720	45.9	14.00
8934	4721	45.6	13.90
8937	4723	44.7	13.60
8940	4725	45.1	13.75
8943	4728	45.9	14.00
8946	4730	44.1	13.45
8948	4733	47.1	14.35
8951	4735	46.2	14.05
8955	4737	45.1	13.75
8944	4738	45.6	13.90
8941	4741	41.3	12.60
8965	4739	45.5	13.85
8969	4739	42.5	12.95
8972	4740	40.6	12.35

8967	4743	46.1	14.05
8969	4744	45.4	13.85
8972	4742	45.6	13.90
8975	4741	41.3	12.60
8978	4743	42.6	13.00
8982	4742	42.5	12.95

8986	4742	41.1	12.55
8988	4738	39.2	11.95
8988	4742	38.8	11.80
8991	4742	39.5	12.05
8995	4743	41.1	12.55
8999	4744	41.5	12.65
9002	4746	42.3	12.90
9006	4747	42.4	12.90
9009	4748	41.0	12.50
9013	4749	40.2	12.25
9017	4751	39.9	12.15

F 820

9620	5264	94.4	28.75
9615	5266	93.4	28.45
9610	5268	93.8	28.60
9605	5270	96.4	29.40
9601	5273	98.7	30.10
9626	5265	91.1	27.75
9631	5266	89.4	27.25
9636	5267	88.1	26.85
9641	5269	87.0	26.50

F 821

8913	4730	25.3	7.70
8914	4734	26.2	8.00
8917	4737	26.1	7.95
8920	4739	26.3	8.00
8923	4742	26.1	7.95
8927	4745	26.6	8.10
8929	4748	27.5	8.40
8933	4750	27.7	8.45
8937	4752	27.8	8.50
8940	4754	28.0	8.50
8944	4756	27.7	8.45
8948	4758	27.5	8.40
8952	4759	28.8	8.75
8956	4761	30.5	9.30
8960	4763	30.2	9.20
8962	4763	30.2	9.20
8967	4764	30.8	9.20
8971	4764	30.6	9.30
8976	4764	30.7	9.35
8979	4765	30.3	9.20
8984	4765	30.1	9.20
8987	4765	31.1	9.50
8989	4765	31.6	9.65
8991	4755	31.6	9.60
8991	4759	29.8	9.10
8991	4763	31.0	9.45
8994	4763	31.8	9.40
8998	4764	31.5	9.60
9002	4764	32.4	9.90

9006	4765	30.8	9.40
9010	4765	30.0	9.15
9015	4765	28.8	8.75
9020	4764	28.0	8.55
9021	4760	29.3	8.90
9022	4758	32.5	9.90
9031	4757	28.5	8.70
9035	4758	28.6	8.70
9039	4759	28.5	8.70
9043	4760	29.1	8.85
9026	4763	28.1	8.55
9030	4763	28.7	8.75
9034	4762	28.7	8.75
9038	4761	28.8	8.75

F 822

9637	5217	16.9	5.15
9642	5216	15.6	4.75
9647	5215	15.1	4.60
9652	5214	15.5	4.70
9657	5214	14.4	4.40
9661	5213	13.1	4.00

F 823

8968	4755	32.1	9.80
8973	4755	31.6	9.65
8977	4756	31.3	9.55
8981	4757	30.8	9.40
8985	4756	30.7	9.35
8989	4756	31.2	9.50

F 824a

9678	5209	29.5	9.00
9683	5208	28.2	8.60
9688	5207	25.2	7.70
9692	5207	21.4	6.50
9697	5206	17.8	5.45
9701	5205	16.2	4.95
9706	5204	14.5	4.40
9706	5202	15.5	4.70
9710	5205	14.1	4.30
9710	5203	14.2	4.35
9715	5206	13.9	4.25
9715	5204	13.2	4.00
9720	5206	12.6	3.85
9720	5202	13.4	4.10
9721	5198	13.0	3.95
9724	5208	12.0	3.65
9729	5209	11.4	3.45
9732	5212	10.8	3.30
9736	5215	10.0	3.05

F 824b

9721	5208	19.1	5.80
9725	5210	18.7	5.70
9729	5213	17.9	5.45

F 825

9003	4698	105.4	32.10
9004	4699	106.3	32.40
9007	4701	106.5	32.45
9010	4703	106.9	32.55
9013	4705	106.0	32.30
9014	4704	106.8	32.55
9015	4703	107.3	32.70
9016	4701	109.0	32.20
9017	4700	111.3	33.90
9012	4706	105.3	32.10
9011	4707	105.9	32.25
9011	4708	106.1	32.35
9010	4709	106.2	32.40
9009	4710	105.4	32.15
9016	4707	105.1	32.05
9020	4708	103.3	31.50
9023	4710	102.1	31.15
9026	4712	102.6	31.25

F 826

9739	5217	9.3	2.85
9741	5221	9.5	2.90
9742	5225	9.2	2.80
9744	5229	9.2	2.80
9747	5225	9.5	2.90
9751	5223	10.9	3.30
9754	5220	10.4	3.15
9757	5217	10.6	3.25
9746	5233	9.2	2.80
9748	5236	9.6	2.95
9749	5240	8.8	2.70
9751	5244	7.5	2.30
9752	5248	7.8	2.40
9753	5251	8.9	2.70
9757	5250	8.2	2.50
9762	5249	9.0	2.75
9766	5247	10.9	3.30
9770	5246	10.2	3.10
9755	5255	8.3	2.55
9757	5259	8.3	2.55
9759	5263	8.8	2.70
9762	5266	9.2	2.80
9763	5270	9.4	2.85

F 828

9765	5274	11.9	3.65
9765	5275	11.0	3.35
9764	5276	10.9	3.30

F 829

9080	4880	28.8	8.75
9079	4885	26.6	8.10
9079	4890	26.1	7.95
9079	4895	25.6	7.80
9079	4900	25.0	7.60
9079	4905	24.6	7.50
9077	4907	24.0	7.30
9082	4904	26.4	8.05
9087	4901	28.2	8.60
9091	4909	29.2	8.90
9080	4910	24.5	7.45
9082	4914	24.5	7.45
9083	4919	24.5	7.45
9085	4923	26.0	7.95
9085	4926	25.1	7.65
9086	4925	24.5	7.45
9088	4923	26.7	8.15
9091	4920	26.8	8.15
9094	4918	26.7	8.15
9097	4915	27.6	8.40
9102	4912	29.5	9.00
9087	4926	26.6	8.10
9088	4929	27.0	8.20
9091	4932	27.0	8.25
9093	4935	27.3	8.30
9096	4938	27.6	8.40
9097	4938	28.2	8.60
9096	4940	28.1	8.55
9099	4937	27.0	8.25
9102	4934	26.0	7.90
9105	4930	25.8	7.85
9108	4927	25.6	7.80
9112	4923	24.7	7.55
9100	4941	27.4	8.35
9104	4943	27.7	8.45
9107	4946	27.8	8.50
9111	4948	28.1	8.55
9114	4950	27.8	8.45
9118	4952	27.6	8.40
9122	4954	27.8	8.45
9126	4956	27.5	8.40
9130	4958	27.1	8.25
9134	4959	26.5	8.05
9138	4960	26.8	8.15
9142	4960	26.8	8.15
9146	4960	27.0	8.20
9150	4960	25.4	7.75
9153	4959	24.1	7.35
9157	4958	23.8	7.25
9160	4958	24.3	7.40
9164	4958	25.1	7.65

9167	4957	25.2	7.65
9171	4957	25.0	7.60
9175	4956	24.5	7.45
9179	4954	24.8	7.55
9183	4952	24.2	7.35
9187	4950	22.6	6.85
9189	4947	22.9	6.95
9192	4945	23.4	7.13
9195	4944	24.6	7.50
9198	4942	25.0	7.60
9201	4940	25.4	7.75
9204	4938	26.6	8.10

9082	4884	28.9	8.80
9085	4888	29.7	9.05
9087	4891	29.6	9.00
9089	4895	29.2	8.90
9091	4899	28.5	8.70
9094	4903	27.8	8.45
9097	4907	27.6	8.40
9100	4910	26.7	8.15
9101	4911	29.2	8.90
9104	4914	28.3	8.60
9107	4918	25.7	7.85
9110	4921	25.0	7.60

F 830

9758	5278	13.0	3.95

F 831

9111	4912	44.1	13.45
9113	4915	42.9	13.10
9115	4918	43.8	13.35
9118	4921	46.5	14.15
9120	4923	48.1	14.65
9124	4926	48.8	14.85
9123	4927	46.8	14.25
9126	4925	46.1	14.05
9128	4923	42.5	12.95
9130	4921	43.0	13.10
9128	4929	47.5	14.45
9130	4932	45.2	13.75
9134	4934	43.8	13.35
9137	4937	42.0	12.80
9140	4939	41.1	12.50
9144	4941	39.4	12.00
9148	4943	40.6	12.35
9152	4945	41.5	12.65
9156	4947	41.6	12.70
9160	4946	40.0	12.20
9167	4945	34.9	10.65
9173	4943	32.7	9.95
9179	4940	34.2	10.40
9186	4938	35.7	10.90
9189	4937	36.3	11.05
9193	4935	35.0	10.65
9196	4932	34.3	10.45
9199	4930	33.7	10.25
9202	4928	32.5	9.90

F 833a

9275	4983	20.0	6.10
9275	4987	19.8	6.05
9278	4996	26.2	7.95
9277	4996	22.7	6.90
9277	4996	20.4	6.20
9276	4996	18.6	5.60
9275	4996	18.2	5.55
9274	4999	17.5	5.30
9273	5004	19.1	5.80
9273	5008	19.6	5.95
9274	5012	19.9	6.05
9275	5016	19.9	6.05
9277	5019	20.0	6.10
9278	5024	19.2	5.85
9280	5028	21.0	6.40
9278	5028	21.5	6.55
9277	5029	21.5	6.55
9281	5027	20.4	6.20
9283	5026	19.3	5.90
9285	5025	19.5	5.95
9282	5031	21.5	6.55
9284	5035	22.2	6.75
9286	5038	22.3	6.80
9288	5042	22.2	6.75
9291	5045	21.9	6.70
9294	5047	21.9	6.65
9297	5046	19.9	6.05
9300	5045	17.5	5.30
9302	5044	19.8	6.05

F 833b

9303	5042	20.0	6.10
9305	5040	20.9	6.35
9306	5038	22.1	6.70
9307	5036	23.2	7.05
9309	5034	22.6	6.90
9310	5032	22.8	6.95
9311	5031	23.9	7.30
9313	5029	26.6	8.10
9308	5029	23.3	7.10
9304	5029	23.0	7.00
9298	5029	25.7	7.85
9293	5029	29.0	8.85

F 836

9840	5327	25.7	7.85
9841	5328	26.1	7.95
9843	5329	25.8	7.85
9844	5330	24.1	7.35
9845	5331	23.9	7.30

F 837

9345	5013	115.1	35.10
9348	5015	116.3	35.45
9351	5018	117.2	35.70
9354	5015	115.6	35.25
9357	5013	116.3	35.45
9360	5010	116.5	35.50
9346	5022	116.1	35.40
9343	5025	114.7	34.95
9340	5028	114.1	34.80
9337	5031	114.5	34.90
9355	5020	116.6	35.55
9358	5023	116.0	35.35

F 839

9344	5108	13.1	3.95
9343	5111	14.8	4.50
9342	5117	14.8	4.50

F 840

9896	5364	95.7	29.15
9898	5363	97.5	29.70
9900	5363	96.9	29.55
9902	5363	96.0	29.25
9903	5361	95.1	29.00
9903	5360	92.1	28.05
9903	5359	88.9	27.10
9898	5363	94.0	28.65
9899	5361	90.1	27.45
9901	5360	88.6	27.00

F 841

9342	5120	20.8	6.35
9341	5124	20.2	6.15
9340	5128	19.9	6.05
9338	5132	19.4	5.90
9340	5132	19.8	6.00
9341	5133	19.7	6.00
9342	5133	20.3	6.20
9344	5133	22.3	6.80
9337	5136	19.7	6.00
9335	5140	19.9	6.05
9334	5144	18.3	5.55
9333	5148	19.0	5.80
9333	5153	18.9	5.75
9332	5157	19.2	5.85
9332	5161	19.1	5.80
9333	5166	18.1	5.50
9334	5165	17.6	5.35
9336	5165	18.4	5.60
9338	5164	18.3	5.55
9340	5164	17.3	5.25
9342	5163	16.9	5.15
9344	5163	20.8	6.35
9334	5169	18.4	5.60
9336	5173	18.9	5.75
9338	5176	19.3	5.85
9341	5179	18.0	5.45
9344	5183	19.4	5.90
9347	5184	19.5	5.95
9351	5188	18.8	5.75
9355	5190	18.4	5.60
9359	5192	18.5	5.65
9362	5194	17.6	5.35

F 843

9337	5133	18.3	5.60
9336	5138	16.3	4.95
9329	5157	16.7	5.05
9329	5161	16.6	5.05
9329	5166	16.3	4.95
9331	5169	16.6	5.05
9333	5173	17.1	5.20
9335	5176	17.5	5.30
9337	5179	16.2	4.90
9342	5184	16.1	4.90
9343	5186	16.3	4.95
9348	5188	15.5	4.75
9352	5191	15.1	4.60
9356	5194	15.2	4.65
9360	5196	14.3	4.35
9364	5197	14.8	4.50
9368	5199	15.3	4.65
9372	5200	15.6	4.75
9376	5201	14.6	4.45
9379	5203	14.4	4.40
9383	5204	14.6	4.45
9387	5205	14.1	4.30

F 845

9357	5130	107.9	32.90
9362	5130	107.5	32.75
9367	5131	106.2	32.35
9372	5131	104.3	31.80
9377	5132	102.6	31.25
9381	5132	100.4	30.60
9386	5131	97.8	29.80
9390	5130	94.9	28.95
9394	5128	93.1	28.40
9396	5126	91.7	27.95
9399	5125	90.2	27.50
9403	5124	89.7	27.35
9408	5124	90.7	27.65
9412	5123	90.2	27.50
9416	5122	91.0	27.75
9420	5122	91.0	27.75

9424	5121	90.8	27.70
9427	5121	90.9	27.70
9359	5133	106.6	32.50
9361	5137	107.2	32.65
9363	5140	106.8	32.55
9365	5143	108.0	32.90
9368	5147	108.8	33.15
9370	5151	109.4	33.35
9372	5155	109.9	33.50
9376	5155	108.7	33.15
9380	5155	106.9	32.60
9385	5155	105.0	32.00
9388	5152	103.3	31.50
9390	5149	102.2	31.15
9392	5147	101.7	31.00
9395	5145	100.3	30.55
9399	5144	98.9	30.15
9403	5143	96.5	29.40
9408	5142	94.8	28.90
9412	5141	95.3	29.05
9416	5139	96.0	29.25
9420	5136	96.0	29.25
9423	5133	95.1	29.00
9426	5131	93.7	28.55
9429	5129	93.3	28.45
9431	5126	92.8	28.30
9435	5126	91.8	28.00
9439	5127	90.6	27.60
9443	5128	89.5	27.30
9447	5129	88.0	26.80

F 847

9358	5178	52.9	16.10
9361	5181	53.5	16.30
9364	5184	52.5	16.00
9365	5180	51.7	15.75
9366	5175	52.9	16.10
9368	5184	51.7	15.75
9372	5184	52.4	16.00
9376	5184	53.0	16.15
9380	5184	54.0	16.45
9385	5184	54.1	16.49
9389	5184	54.6	16.60
9393	5184	54.3	16.55
9397	5185	54.1	16.50
9400	5181	52.1	15.90
9402	5177	51.3	15.60
9404	5173	52.1	15.90
9401	5184	51.6	15.70
9405	5184	51.0	15.55
9409	5183	49.6	15.15
9413	5183	48.1	14.65
9416	5182	46.5	14.15
9420	5182	45.6	13.90
9424	5181	46.0	14.00
9428	5181	46.5	14.15
9432	5180	46.3	14.10
9435	5180	45.7	13.90
9431	5162	43.7	13.30
9432	5155	42.2	12.85

F 849

9392	5197	40.5	12.35
9396	5198	39.7	12.10
9401	5199	40.1	12.20
9405	5199	40.5	12.35
9410	5199	40.8	12.40
9414	5200	40.5	12.35
9418	5200	39.8	12.10
9417	5203	39.6	12.05
9419	5196	39.9	12.15
9423	5200	39.7	12.10
9427	5199	39.4	12.00
9431	5199	39.1	11.90
9436	5199	37.2	11.35
9440	5198	35.5	10.80

F 851

9390	4202	17.1	5.20
9394	5202	18.0	5.50
9397	5203	18.3	5.55
9401	5204	18.4	5.60
9405	5205	18.4	5.60
9409	5206	18.1	5.50
9413	5207	17.8	5.40
9413	5206	17.5	5.35
9414	5206	17.0	5.20
9414	5205	16.3	4.95
9414	5204	16.7	5.10
9413	5208	17.0	5.20
9412	5208	14.4	4.40
9412	5209	14.6	4.45
9418	5207	17.9	5.45
9422	5207	17.6	5.35
9426	5207	16.6	5.05
9429	5206	16.7	5.05
9434	5206	16.9	5.15
9438	5205	16.2	4.95
9466	5198	16.3	4.95
9470	5197	15.3	4.65
9475	5196	15.5	4.70
9480	5195	15.4	4.70
9485	5194	15.6	4.75
9482	5190	15.4	4.70
9482	5191	12.9	3.90
9482	5193	15.9	4.85
9483	5195	12.8	3.90

9483	5196	9.9	3.00
9491	5193	15.9	4.85
9496	5191	15.8	4.80
9501	5190	15.7	4.75
9506	5189	15.5	4.70
9511	5188	15.8	4.80
9516	5187	15.8	4.80
9521	5187	14.7	4.45
9526	5186	13.3	4.05
9530	5185	12.6	3.80
9535	5184	11.2	3.40

F 853

9391	5206	14.5	4.40
9395	5206	14.6	4.45
9398	5207	14.8	4.50
9402	5207	14.2	4.35
9405	5207	14.5	4.40
9408	5208	15.0	4.55
9412	5208	14.5	4.45
9416	5208	14.6	4.45
9420	5209	14.1	4.30
9424	5209	14.4	4.35
9428	5208	14.6	4.45
9432	5208	14.6	4.45
9431	5208	14.2	4.30
9441	5207	13.1	4.00
9444	5205	13.4	4.05
9448	5204	13.7	4.15
9453	5203	12.5	3.80
9458	5202	13.3	4.05
9463	5201	12.4	3.80

F 855

9456	5147	42.0	12.80
9451	5146	41.7	12.70
9446	5145	39.8	12.15
9442	5147	39.1	11.90
9438	5149	37.7	11.50
9435	5153	37.8	11.50
9434	5157	35.8	10.90
9434	5161	36.7	11.20
9435	5165	36.6	11.15
9436	5169	35.1	10.70
9437	5173	33.3	10.15
9438	5177	32.5	9. 90

F 863

9599	5105	122.3	37.30
9600	5101	123.7	37.70
9601	5097	123.8	37.75
9602	5093	124.1	37.80
9598	5109	122.7	37.40
9597	5113	121.9	37.15
9596	5117	120.4	36.70
9603	5106	122.6	37.35
9608	5108	122.6	37.35
9613	5109	122.5	37.35
9618	5110	122.2	37.25
9623	5111	118.3	36.05
9628	5113	116.6	35.55
9628	5109	116.9	35.60
9629	5106	116.4	35.45
9627	5117	116.8	35.60
9626	5121	116.7	35.55
9632	5114	116.2	35.40
9636	5115	115.7	35.25
9640	5116	115.6	35.25
9641	5116	115.4	35.15
9645	5117	114.4	34.85
9650	5117	113.8	34.70
9654	5118	113.4	34.55
9659	5119	113.8	34.65
9664	5119	114.5	34.90
9667	5116	113.0	34.45
9670	5118	108.7	33.15
9672	5122	101.2	30.85
9674	5126	94.0	28.65

F 865

9683	5140	96.4	29.35
9688	5141	96.6	29.45
9691	5152	97.5	29.70
9692	5148	97.2	29.60
9694	5144	97.1	29.60
9695	5139	94.5	28.80
9696	5135	95.5	28.10
9698	5130	98.3	29.95
9699	5128	101.6	30.95
9702	5132	97.1	29.60
9707	5134	93.7	28.55
9712	5137	94.1	28.70
9717	5139	91.7	27.95
9722	5142	87.1	26.55
9719	5145	86.8	26.45
9718	5148	84.2	26.65
9716	5151	83.1	25.30
9715	5155	87.5	26.65
9726	5144	83.6	25.50
9730	5146	80.0	24.40
9733	5147	77.5	23.60
9737	5149	72.4	22.05
9741	5151	69.0	21.05
9745	5153	66.8	20.35
9750	5155	67.0	20.40
9754	5157	66.3	20.20

F 869

9790	5208	43.5	13.25
9794	5213	41.3	12.60
9797	5217	41.3	12.60

F 871

9827	5181	105.2	32.05
9828	5185	104.0	31.70
9829	5189	101.2	30.85
9830	5194	100.6	30.65
9831	5198	100.5	30.65
9832	5201	100.0	30.45
9833	5205	97.5	29.70
9833	5209	97.4	29.65
9833	5213	96.3	29.35
9832	5217	94.5	28.80
9831	5222	92.3	28.15
9827	5220	92.5	28.15
9827	5216	95.0	28.95
9827	5212	95.8	29.20

F 873

9799	5238	25.5	7.75
9802	5238	24.0	7.30
9806	5241	23.0	7.00
9810	5244	21.9	6.65
9814	5247	21.2	6.45
9813	5250	19.4	5.90
9812	5253	18.9	5.75
9815	5245	24.4	7.45
9816	5243	27.0	8.20
9818	5250	19.8	6.05
9822	5253	19.2	5.85
9826	5256	19.1	5.80
9830	5259	18.9	5.75
9834	5262	18.0	5.45
9832	5265	17.6	5.35
9838	5260	18.7	5.70
9843	5256	18.5	5.65
9837	5265	17.8	5.45
9840	5269	18.3	5.55
9843	5273	17.7	5.40
9846	5277	17.3	5.25
9849	5281	13.4	4.05

F 875

9802	5248	10.7	3.25
9807	5252	10.2	3.10
9811	5256	9.9	3.00
9815	5259	9.3	2.80
9815	5257	9.7	2.95
9810	5263	9.8	2.95
9806	5267	9.2	2.80
9819	5261	9.2	2.80
9823	5264	8.8	2.65
9827	5266	9.0	2.75
9831	5269	8.7	2.65
9835	5271	8.6	2.60
9839	5274	7.8	2.40
9843	5276	7.9	2.40
9847	5279	7.4	2.25
9849	5281	10.5	3.20
9852	5284	9.7	2.95
9855	5287	8.9	2.70
9855	5286	9.6	2.95
9854	5287	8.9	2.70
9853	5288	8.9	2.70
9852	5289	9.4	2.85
9858	5290	8.5	2.60
9862	5293	8.8	2.70
9865	5296	8.3	2.50
9871	5299	8.3	2.55
9875	5302	8.7	2.65
9876	5300	12.6	3.85
9876	5300	10.9	3.30
9876	5301	9.7	2.95
9876	5301	8.9	2.70
9876	5302	8.5	2.60
9876	5302	7.9	2.40
9876	5303	7.6	2.30
9875	5304	7.4	2.25
9879	5304	8.3	2.50
9883	5305	7.7	2.35
9887	5307	8.1	2.45
9891	5308	7.9	2.40
9895	5309	7.5	2.30
9900	5312	7.3	2.20
9905	5313	8.0	2.45
9909	5314	9.3	2.85
9914	5314	10.7	3.25
9933	5293	15.0	4.55
9933	5288	16.2	4.90
9933	5283	15.3	4.65

F 877

9869	5254	65.4	19.95
9871	5257	64.7	19.70
9874	5260	65.7	20.00
9877	5264	68.3	20.80
9879	5268	69.8	21.25
9877	5269	70.2	21.40
9879	5273	69.5	21.20
9881	5273	69.7	21.25
9889	5274	67.1	20.45
9887	5275	67.7	20.60

9884	5277	66.1	20.15
9895	5278	67.9	20.70
9896	5281	67.8	20.65
9892	5282	67.0	20.40

F 879

9870	5265	60.7	18.50
9866	5267	60.3	18.35
9863	5269	62.2	18.95
9872	5268	60.8	18.50
9868	5270	61.7	18.80
9865	5272	63.0	19.20
9875	5272	61.2	18.65
9871	5274	61.0	18.60
9867	5276	60.4	18.40

F 883

9881	5278	48.0	14.60
9878	5281	45.5	13.85
9876	5285	43.0	13.10
9872	5287	40.7	12.40

F 885

9885	5284	46.5	14.15
9881	5287	43.3	13.20
9878	5290	40.1	12.20

F 887

9870	5296	36.1	11.00
9878	5306	35.4	10.80
9881	5299	35.4	10.80
9886	5298	32.4	9.90
9892	5302	36.2	11.05
9891	5301	34.9	10.65
9890	5297	32.0	9.75
9895	5296	32.2	9.80
9898	5295	32.3	9.85
9902	5294	30.6	9.35

F 889

9907	5311	28.3	8.60
9912	5309	31.5	9.60
9916	5307	32.8	10.00
9920	5301	31.8	9.70
9919	5298	32.0	9.70
9915	5299	30.7	9.35
9914	5295	28.2	8.60

F 891

9920	5308	15.6	4.75
9922	5306	15.2	4.60
9925	5305	15.0	4.55

Appendix 1(b). Areally distributed height layout patterns.

This appendix contains those heights collected on rectangular grid, randomly distributed and clustered height layouts over several fragments in the Fleurs Castle area. The format for the rectangular gridded heights is arranged across the page as follows:

8 Figure National Grid referance.	P	Q	Height (in feet)	Height (in metres)

The symbols P and Q refer to distance down and perpendicular distance from a sinuous line around the rear of the terrace fragment (Chapter 11). The format for randomly distributed heights and for those on a clustered distribution is, as in appendix 1(a), reproduced twice across each page set out thus:

8 Figure National Grid reference	Height (in feet)	Height (in metres)

Fragment 584 (Rectangular grid height layout)

Grid Reference	P Value	Q Value	Height (feet)	Height (metres)
7083 3389	41.5	4.95	129.9	39.60
7075 3382	39.4	5.30	130.2	39.70
7080 3384	40.2	4.85	129.2	39.40
7084 3385	40.9	4.40	128.6	39.20
7019 3359	23.6	6.40	136.6	41.65
7023 3361	24.3	6.55	135.7	41.35
7028 3362	25.0	6.80	134.2	40.90
7032 3364	25.7	7.05	133.0	40.55
7037 3365	26.7	7.30	133.2	40.60
7041 3367	27.6	7.50	133.0	40.55
7046 3368	32.9	6.95	133.4	40.65
7050 3369	33.9	6.65	133.2	40.60
7055 3371	34.7	6.35	132.2	40.30
7059 3372	35.4	6.10	130.7	39.85
7063 3374	36.5	5.75	130.0	39.60
7068 3375	37.2	5.45	130.9	39.90
7072 3377	38.0	5.10	131.3	40.00
7077 3378	39.0	4.70	131.3	40.00
7081 3379	39.7	4.25	130.5	39.80
7020 3355	23.9	5.65	135.0	41.15
7025 3357	24.6	5.90	134.9	41.10
7029 3358	25.3	6.10	134.6	41.05
7034 3359	26.2	6.35	135.3	41.25
7038 3361	27.0	6.55	136.1	41.50
7043 3362	31.6	6.50	134.7	41.05
7047 3364	32.6	6.25	133.7	40.75
7052 3365	33.7	6.00	132.2	40.30
7056 3367	34.5	5.75	131.1	39.95
7061 3368	35.3	5.45	132.3	40.35
7065 3369	36.1	5.10	132.5	40.40
7069 3371	36.9	4.80	131.3	40.00
7072 3372	37.5	4.45	131.9	40.20
7077 3374	38.4	4.05	132.5	40.40
7081 3375	39.2	3.65	131.2	40.00
7026 3352	24.9	5.20	133.7	40.75
7031 3353	25.6	5.50	133.4	40.65
7035 3355	26.3	5.70	135.3	41.25
7040 3356	27.3	5.90	135.0	41.15
7044 3358	29.0	6.00	134.1	40.85
7049 3359	32.3	5.60	134.1	40.85
7053 3361	33.3	5.35	133.5	40.70
7057 3362	34.1	5.00	132.9	40.50
7062 3363	34.9	4.75	133.6	40.70
7066 3365	35.7	4.45	132.1	40.25
7071 3366	36.4	4.10	133.0	40.55
7075 3368	37.1	3.80	133.2	40.60
7079 3369	37.8	3.40	132.9	40.50
7055 3356	32.9	4.65	134.3	40.95
7059 3357	33.8	4.35	133.7	40.75

__Erratum__ The continuous line on the opposite page indicates the commencement of the rectangular gridded heights on Fragment 585. The caption has been omitted.

7064	3359	34.5	4.05	134.6	41.05
7068	3360	35.3	3.75	132.4	40.35
7072	3362	36.1	3.40	133.9	40.80
7077	3363	36.8	3.10	132.7	40.45
7081	3364	37.5	2.70	131.0	39.95
7065	3355	34.2	3.40	134.3	40.95
7069	3356	34.9	3.15	133.3	40.65
7073	3357	35.8	2.80	132.0	40.25
7078	3359	36.4	2.45	131.9	40.20
7029	3320	25.5	0.10	133.4	40.65
7015	3320	23.4	0.10	135.4	41.25
7019	3321	24.0	0.30	132.9	40.50
7024	3322	24.7	0.50	132.8	40.50
6877	3280	0.2	0.30	147.1	44.85
6881	3282	0.9	0.00	146.4	44.60
7010	3323	22.5	0.60	130.7	39.85
7014	3325	23.1	0.80	134.3	40.95
7018	3326	23.7	1.00	136.4	41.55
6880	3286	1.1	0.70	147.1	44.85
6884	3287	1.8	0.35	146.5	44.65
6889	3289	2.5	0.00	146.4	44.60
7001	3325	21.1	0.70	135.3	41.25
7005	3326	21.7	1.00	133.0	40.55
7009	3328	22.3	1.25	132.3	40.35
6883	3292	2.1	1.00	146.5	44.65
6887	3293	2.7	0.65	147.2	44.85
6892	3294	3.4	0.35	145.8	44.45
6896	3296	4.0	0.05	144.4	44.00
6973	3321	16.9	0.10	138.1	42.10
6978	3322	17.6	0.30	135.8	41.40
6982	3324	18.3	0.45	135.1	41.20
6986	3325	19.0	0.65	136.0	41.45
6991	3326	19.6	0.85	134.3	40.95
6995	3328	20.2	1.10	136.2	41.50
6999	3329	20.9	1.30	137.1	41.80
7003	3330	21.4	1.60	136.7	41.65
6886	3297	3.0	1.25	147.5	44.95
6890	3298	3.7	1.00	147.3	44.90
6894	3300	4.3	0.70	147.3	44.90
6899	3301	5.0	0.40	144.0	43.90
6904	3303	5.6	0.20	142.8	43.55
6931	3312	10.1	0.00	142.4	43.40
6935	3314	10.8	0.00	140.9	42.95
6939	3315	11.5	0.05	141.9	43.25
6943	3316	12.1	0.10	139.9	42.65
6947	3317	12.8	0.20	138.5	42.20
6951	3319	13.4	0.20	136.7	41.65
6955	3320	14.1	0.30	138.2	42.10
6959	3321	14.7	0.40	136.7	41.65
6963	3322	15.3	0.50	136.0	41.45
6968	3324	16.0	0.65	138.0	42.05
6972	3325	16.7	0.80	137.7	41.95
6976	3326	17.4	0.95	136.5	41.60
6981	3328	18.1	1.15	136.4	41.55
6985	3329	18.8	1.30	135.9	41.40
6989	3331	19.4	1.50	136.9	41.75

6994	3332	20.0	1.75	136.9	41.75
6998	3333	20.6	2.00	137.9	42.05
7002	3335	21.2	2.25	137.0	41.75
6889	3303	4.0	1.60	146.2	44.55
6893	3304	4.6	1.35	146.2	44.55
6897	3306	5.2	1.10	146.8	44.75
6902	3307	5.8	0.90	146.8	44.75
6906	3309	6.4	0.75	143.1	43.60
6910	3310	7.0	0.65	141.3	43.05
6914	3311	7.6	0.60	141.5	43.15
6918	3313	8.2	0.55	142.6	43.45
6922	3314	8.8	0.55	142.1	43.30
6926	3315	9.5	0.55	142.1	43.30
6929	3316	10.1	0.70	140.7	42.90
6933	3318	10.7	0.75	139.7	42.60
6938	3319	11.4	0.75	139.9	42.65
6942	3320	12.1	0.80	140.2	42.75
6946	3322	12.7	0.90	139.1	42.40
6950	3323	13.3	0.95	139.4	42.50
6954	3324	14.0	1.00	138.3	42.15
6958	3325	14.6	1.10	138.2	42.10
6962	3327	15.2	1.20	137.1	41.80
6966	3328	15.9	1.35	137.7	41.95
6971	3329	16.6	1.50	137.5	41.90
6975	3331	17.3	1.65	137.2	41.80
6979	3332	17.9	1.80	137.1	41.80
6984	3334	18.6	2.00	136.7	41.65
6988	3335	19.3	2.20	137.2	41.80
6993	3336	19.8	2.45	138.1	42.10
6997	3338	20.4	2.65	137.8	42.00
7001	3339	21.0	2.90	135.3	41.25
6896	3310	5.4	1.80	145.2	44.25
6900	3312	6.0	1.55	145.0	44.20
6904	3313	6.5	1.40	143.9	43.85
6908	3314	7.1	1.35	143.1	43.60
6912	3316	7.7	1.30	144.1	43.90
6916	3317	8.3	1.25	142.9	43.55
6920	3318	8.8	1.25	142.9	43.55
6924	3319	9.4	1.35	142.1	43.30
6928	3321	10.1	1.40	141.2	43.05
6932	3322	10.7	1.40	141.1	43.00
6936	3323	11.4	1.45	141.0	43.00
6940	3325	12.0	1.50	139.7	42.60
6944	3326	12.7	1.55	140.0	42.65
6948	3327	13.3	1.60	139.7	42.60
6952	3329	14.0	1.65	138.9	42.35
6956	3330	14.6	1.80	138.4	42.20
6960	3331	15.1	1.90	138.5	42.20
6965	3332	15.8	2.05	137.5	41.90
6969	3334	16.4	2.20	138.0	42.05
6973	3335	17.1	2.35	137.7	41.95
6978	3337	17.8	2.50	137.1	41.80
6982	3338	18.4	2.70	137.6	41.95
6987	3339	19.1	2.90	138.0	42.05
6991	3341	19.6	3.10	138.5	42.20
6995	3342	20.2	3.35	135.2	41.20
6899	3316	6.2	2.30	144.7	44.10
6903	3317	6.7	2.20	144.5	44.05
6907	3319	7.2	2.10	145.1	44.25
6911	3320	7.7	2.00	144.9	44.15

6915	3321	8.3	2.00	144.3	44.00
6919	3322	8.9	2.00	143.7	43.80
6923	3324	9.4	2.05	143.1	43.60
6927	3325	10.0	2.10	142.0	43.30
6931	3326	10.7	2.15	141.4	43.10
6935	3328	11.3	2.20	139.5	42.50
6939	3329	12.0	2.25	140.3	42.75
6943	3330	12.6	2.30	140.4	42.80
6947	3332	13.2	2.35	138.9	42.35
6951	3333	13.9	2.40	138.8	42.30
6955	3334	14.5	2.50	139.7	42.60
6959	3336	15.0	2.65	139.4	42.50
6963	3337	15.7	2.75	138.7	42.30
6968	3338	16.3	2.90	138.6	42.25
6972	3340	17.0	3.05	138.7	42.30
6976	3341	17.7	3.20	138.0	42.05
6981	3342	18.3	3.45	137.5	41.90
6985	3344	18.9	3.60	137.9	42.05
6990	3345	19.5	3.80	136.3	41.55
6902	3322	6.8	2.80	144.6	44.05
6905	3323	7.2	2.75	144.1	43.90
6909	3324	7.8	2.70	143.7	43.80
6913	3325	8.3	2.70	143.0	43.60
6917	3327	8.8	2.65	142.6	43.45
6922	3328	9.4	2.70	141.8	43.20
6926	3329	10.0	2.75	141.3	43.05
6930	3331	10.7	2.80	141.3	43.05
6934	3332	11.3	2.85	140.8	42.90
6938	3333	12.0	2.90	141.1	43.00
6942	3334	12.6	2.95	139.8	42.60
6946	3336	13.2	3.05	139.7	42.60
6950	3337	13.9	3.10	139.8	42.60
6954	3338	14.4	3.20	140.4	42.80
6958	3340	14.9	3.30	139.3	42.45
6962	3341	15.5	3.45	139.7	42.60
6967	3343	16.2	3.60	139.6	42.55
6971	3344	16.9	3.75	139.8	42.60
6975	3345	17.5	3.95	139.6	42.55
6980	3347	18.1	4.10	137.8	42.00
6984	3348	18.7	4.30	137.6	41.95
6908	3328	7.8	3.35	144.0	43.90
6912	3329	8.3	3.35	143.5	43.75
6916	3331	8.8	3.35	143.3	43.70
6920	3332	9.3	3.40	143.2	43.65
6924	3333	9.9	3.45	142.2	43.35
6928	3335	10.6	3.50	141.9	43.25
6932	3336	11.2	3.50	140.9	42.95
6936	3337	11.9	3.55	140.6	42.85
6940	3339	12.6	3.60	141.0	43.00
6944	3340	13.1	3.70	141.4	43.10
6948	3341	13.7	3.80	141.4	43.10
6952	3343	14.4	3.90	140.5	42.80
6956	3344	14.9	4.00	139.5	42.50
6961	3345	15.4	4.15	139.6	42.55
6965	3347	16.0	4.30	139.7	42.60

6969 3348	16.7	4.45	139.8	42.60
6974 3349	17.3	4.60	139.6	42.55
6978 3351	18.0	4.80	138.2	42.10
6919 3336	9.3	4.10	143.4	43.70
6923 3337	9.9	4.15	142.7	43.50
6927 3339	10.5	4.15	143.3	43.70
6931 3340	11.2	4.20	142.4	43.40
6935 3341	11.9	4.25	142.6	43.45
6939 3343	12.5	4.30	142.1	43.30
6943 3344	13.1	4.40	141.8	43.20
6947 3345	13.7	4.45	141.5	43.15
6951 3347	14.3	4.55	141.2	43.05
6955 3348	14.8	4.65	141.5	43.15
6959 3350	15.3	4.80	141.1	43.00
6964 3351	15.9	5.00	140.7	42.90

Fragment 586/588

Grid Reference	P Value	Q Value	Height (feet)	Height (metres)
7016 3348	23.3	4.50	122.7	37.40
7017 3340	23.5	3.85	123.3	37.60
7021 3345	24.2	4.15	121.5	37.05
7025 3347	24.9	4.35	124.5	37.95
7030 3348	25.6	4.60	123.8	37.75
7023 3341	24.5	3.45	122.2	37.25
7027 3343	25.2	3.70	122.7	37.40
7031 3344	26.0	3.90	124.8	38.05
7036 3345	26.7	4.15	127.1	38.75
7040 3347	27.4	4.35	123.5	37.65
7044 3348	28.6	4.65	125.5	38.25
7048 3349	31.2	4.30	124.8	38.05
7052 3351	32.0	4.10	123.5	37.65
7024 3337	24.7	2.80	123.7	37.70
7028 3338	25.4	3.00	121.8	37.10
7032 3339	26.2	3.25	122.7	37.40
7037 3341	26.9	3.45	122.6	37.35
7041 3342	27.5	3.70	125.9	38.35
7045 3344	28.7	3.80	125.7	38.30
7050 3345	31.0	3.65	125.8	38.35
7054 3346	31.7	3.45	125.8	38.35
7058 3348	32.5	3.20	125.6	38.30
7062 3349	33.3	2.95	123.4	37.60
7030 3334	25.6	2.40	123.1	37.50
7034 3335	26.4	2.60	120.5	36.75
7038 3337	27.1	2.80	123.0	37.50
7043 3338	27.8	3.00	123.3	37.60
7047 3339	28.8	3.10	121.5	37.05
7051 3341	30.5	3.00	123.0	37.50
7055 3342	31.5	2.75	123.5	37.65
7060 3343	32.2	2.55	122.4	37.30
7064 3345	33.0	2.30	121.9	37.15
7068 3346	33.7	2.05	121.1	36.90

7072	3347	34.3	1.80	118.5	36.10
7077	3349	34.9	1.50	118.4	36.10
7035	3331	26.6	1.95	121.9	37.15
7040	3332	27.2	2.15	120.1	36.60
7044	3334	28.0	2.35	123.2	37.55
7048	3335	29.1	2.40	123.4	37.60
7052	3336	30.2	2.35	122.9	37.45
7057	3338	31.3	2.10	122.4	37.30
7061	3339	32.0	1.90	120.7	36.80
7065	3340	32.8	1.65	119.8	36.50
7041	3328	27.4	1.50	120.8	36.80
7045	3330	28.2	1.65	122.6	37.35
7049	3331	29.2	1.70	120.9	36.85
7054	3332	30.1	1.65	121.2	36.95
7058	3334	31.1	1.45	121.4	37.00

__Erratum__ The continuous line on the opposite page indicates the commencement of the clustered height layout values on Fragment 585: the caption has been omitted. These heights were added to those around the rim and across Fragment 585 (Appendix 1(a)) to provide all of the values employed in trend surface calculations based on the clustered data layout.

FRAGMENT 585 (Randomly distributed heights within 1 Km. square 69/33)

Grid ref.	Height (ft)	Height (m)	Grid ref.	Height (ft)	Height (m)
6944 3338	140.5	42.80	6990 3332	137.0	41.75
6953 3341	140.5	42.80	6974 3337	137.8	42.00
6937 3336	140.8	42.90	6909 3326	143.8	43.85
6906 3305	142.0	43.30	6985 3330	136.0	41.45
6988 3338	137.7	41.95	6953 3325	138.6	42.25
6973 3318	136.8	41.70	6952 3346	139.3	42.45
6949 3336	139.3	42.45	6954 3318	137.2	41.80
6947 3333	138.9	42.35	6915 3317	143.2	43.65
6931 3343	142.5	43.45	6922 3321	143.0	43.60
6964 3322	136.0	41.45	6911 3317	144.4	44.00
6946 3337	139.7	42.60	6985 3345	137.8	42.00
6938 3336	140.9	42.95	6981 3352	137.9	42.05
6974 3338	138.1	42.10	6997 3341	135.3	41.25
6948 3334	139.2	42.45	6930 3327	141.4	43.10
6925 3326	142.3	43.35	6929 3326	141.8	43.20
6923 3312	142.3	43.35	6960 3339	139.4	42.50
6936 3318	139.8	42.60	6991 3341	138.5	42.50
6991 3337	138.2	42.10	6946 3319	139.0	42.35
6942 3338	140.7	42.90	6937 3316	140.8	42.90
6973 3330	137.4	41.90	6916 3327	142.7	43.50
6980 3324	135.6	41.35	6960 3332	138.5	42.20
6951 3338	140.0	42.65	6946 3338	140.2	42.75
6999 3339	136.3	41.55	6946 3323	139.1	42.40
6928 3315	141.3	43.05	6928 3318	141.6	43.15
6907 3317	144.1	43.90	6919 3316	142.6	43.45
6977 3337	137.2	41.80	6913 3332	143.6	43.75
6972 3351	139.8	42.60	6988 3335	137.2	41.80
6997 3338	137.8	42.00	6956 3329	138.4	42.20
6978 3344	138.3	42.15	6997 3335	137.8	42.00
6942 3343	141.6	43.15	6947 3327	139.7	42.60
6934 3336	140.8	42.90	6912 3323	144.2	43.95
6915 3319	143.6	43.75	6985 3331	136.2	41.50
6975 3346	139.6	42.55	6973 3341	139.6	42.55
6920 3321	143.3	43.70	6955 3351	139.7	42.60
6990 3336	137.3	41.85	6927 3332	141.6	43.15
6923 3319	142.5	43.45	6917 3334	143.3	43.70
6964 3319	141.0	43.00	6958 3319	137.5	41.90
6906 3318	145.1	44.25	7000 3336	137.4	41.90
6976 3335	137.4	41.90	6959 3337	139.3	42.45
6979 3330	136.8	41.70	6905 3314	143.8	43.85
6969 3326	137.9	42.05	6987 3339	138.0	42.05
6951 3335	139.2	42.45	6990 3340	138.3	42.15
6960 3340	139.5	42.50	6961 3329	137.7	41.95
6954 3320	138.2	42.10			
6921 3329	142.0	43.30	6928 3315	141.2	43.05

6973 3321	138.1	42.10
6978 3322	135.8	41.40
6982 3324	135.1	41.20
6986 3325	136.0	41.45
6991 3326	134.3	40.95
6960 3331	138.5	42.20
6965 3332	137.5	41.90
6969 3335	138.0	42.05
6973 3335	137.7	41.95
6978 3337	137.1	41.80
6904 3303	142.8	43.55
6931 3312	142.4	43.40
6935 3314	140.9	42.95
6939 3315	141.9	43.25
6943 3316	139.9	42.65
6947 3317	138.5	42.20
6961 3345	139.6	42.55
6965 3347	139.7	42.60
6969 3348	139.8	42.60
6974 3349	139.6	42.55
6978 3351	138.2	42.10
6919 3336	143.4	43.70
6923 3337	142.7	43.50
6927 3339	143.4	43.70

Appendix I (c) River surface heights.

These accurate spot levels are believed to represent to an acceptable degree of accuracy the normal or low water river level of the Tweed water surface and adjacent sections of tributaries. The format is identical to that used in appendix I(a):

8 Figure National Grid Reference	Height (in feet)	Height (in metres)

This is reproduced twice across each page.

0548	1755	1066.6	325.10	1464	3564	601.9	183.45
0542	1764	1062.6	323.90	1523	3562	596.3	181.75
0535	1800	1051.8	320.60	1603	3535	591.0	180.15
0545	1822	1039.5	316.85	1862	4073	589.0	179.55
0547	1857	1024.5	312.25	1642	3550	587.3	179.00
0550	1883	1017.0	310.00	1756	3631	578.2	176.25
0538	1916	1010.1	307.90	1782	3654	575.2	175.30
0548	1943	999.5	304.65	1980	4060	574.6	175.15
0559	1975	995.4	303.40	1833	3735	569.9	173.70
0553	1992	988.8	301.40	1845	3755	569.9	173.70
0561	2008	961.9	293.20	2013	4045	564.8	172.15
0610	2145	938.3	286.00	1906	3825	563.6	171.80
0695	2211	910.8	277.60	1924	3850	563.0	171.60
0732	2227	901.1	274.65	2042	4029	561.4	171.10
0750	2244	893.6	272.35	1926	3869	561.2	171.05
0751	2259	889.5	271.10	1949	3914	558.6	170.25
0765	2275	879.7	268.15	1977	3969	553.8	168.80
0785	2282	875.9	266.95	2102	3995	550.4	167.75
0810	2297	860.3	262.20	2075	3975	550.0	167.65
0869	2308	851.7	259.60	2111	3978	547.7	166.95
0859	2320	849.0	258.80	2222	3908	541.1	164.95
0856	2322	848.3	258.55	2302	3974	533.7	162.65
0915	2347	840.1	256.05	2318	4006	531.3	161.95
0882	2351	833.2	253.95	2327	4020	528.7	161.15
0897	2373	823.5	251.00	2359	4044	526.5	160.50
0932	2401	815.4	248.55	2428	4039	522.3	159.20
1008	2400	814.8	248.35	2505	4032	514.6	156.85
0962	2415	808.3	246.35	2630	3992	505.1	153.95
1011	2436	794.4	242.15	2673	4001	502.9	153.30
1017	2450	788.0	240.20	2796	3899	494.5	150.70
0988	2449	787.7	240.10	2943	3897	485.5	148.00
1030	2473	778.8	237.40	3018	3931	480.3	146.40
1051	2507	770.1	234.75	3081	3906	475.3	144.85
1073	2536	762.8	232.50	3082	3800	469.3	143.05
1100	2612	744.2	226.85	3103	3722	464.4	141.55
1063	2836	731.8	223.05	3135	3703	463.0	141.10
1121	2880	727.2	221.65	3238	3623	459.8	140.15
1122	2885	724.3	220.75	3327	3588	456.2	139.05
1123	2890	722.5	220.20	3375	3614	449.8	137.10
1125	2894	719.7	219.35	3477	3704	441.4	134.55
1073	2842	719.3	219.25	3712	3726	421.6	128.50
1212	3063	665.4	202.80	3795	3775	412.4	125.70
1253	3175	646.5	197.05	3887	3743	406.9	124.00
1243	3231	641.9	195.65	4753	3749	405.4	123.55
1223	3275	636.6	194.05	3921	3737	403.5	123.00
1234	3345	629.9	192.00	3963	3717	400.3	122.00
1193	3547	624.9	190.45	4001	3648	398.5	121.45
1306	3398	621.4	189.40	4074	3617	394.0	120.10
1274	3479	618.5	188.50	4210	3610	385.4	117.45
1331	3442	617.1	188.10	4267	3580	381.7	116.35
1312	3494	614.8	187.40	4304	3527	379.8	115.75
1340	3498	613.2	186.90	4294	3546	379.7	115.75
1333	3523	611.4	186.35	4373	3510	376.1	114.65
1386	3554	607.6	185.20	4423	3494	368.9	112.45
1390	3556	607.6	185.20	4447	3483	368.2	112.25

4522	3448	362.2	110.40
4545	3388	355.0	108.20
4541	3351	350.8	106.90
4534	3328	349.2	106.45
4580	3257	342.2	104.30
4676	3245	334.9	102.10
4731	3238	334.0	101.80
4818	3139	330.1	100.60
4786	3205	329.2	100.35
4851	3150	326.4	99.50
4808	3198	324.2	98.80
4844	3201	323.2	98.50
4876	3216	322.6	98.35
4881	3223	319.7	97.45
4892	3225	317.7	96.85
4906	3263	317.6	96.80
5021	3369	308.1	93.90
5171	3545	291.9	88.95
5236	3542	288.1	87.80
5283	3485	282.6	86.15
5366	3480	278.0	84.75
5452	3463	271.8	82.85
5598	3491	262.4	80.00
5663	3452	254.9	77.70
5799	3474	252.6	77.00
5864	3461	249.2	75.95
5820	3413	243.7	74.30
5844	3300	226.7	69.10
5886	3206	221.1	67.40
5883	3146	216.8	66.10
5944	3162	207.9	63.35
6046	3242	200.9	61.25
6095	3203	197.6	60.25
6164	3115	177.3	54.05
6231	3162	173.7	52.95
6393	3150	166.4	50.70
6495	3187	161.8	49.30
6594	3127	154.2	47.00
6790	3183	136.8	41.70
6853	3248	132.5	40.40
6976	3360	113.9	34.70
7023	3336	110.1	33.55
7105	3368	107.1	32.65
7111	3388	105.9	32.30
7164	3428	102.9	31.35
7225	3427	101.8	31.05
7309	3362	92.6	28.20
7419	3475	86.2	26.25
7506	3532	83.0	25.30
7555	3633	80.1	24.40
7740	3807	70.0	21.35
7996	3885	54.9	16.75
8272	3885	45.9	14.00
8547	3909	40.6	12.35
8521	4040	35.3	10.75
8635	4129	28.7	8.75
8642	4188	27.7	8.45
8677	4301	24.9	7.60
8703	4300	24.9	7.60
8705	4296	24.5	7.45
8852	4541	21.9	6.70
9073	4859	10.5	3.20
9075	4880	10.3	3.15
9336	5100	6.9	2.10
9370	5200	5.0	1.50

Appendix 1(c) : **Flood Levels.**

Grid reference		Height (feet)	Height (metres)	Date
5106	3497	312.0	95.10	13. 8.1948
5106	3497	311.2	94.85	5.11.1926
5106	3497	309.7	94.40	27. 2.1924
7107	3419	115.9	35.35	13. 8.1948
7107	3419	115.4	35.15	9. 2.1831
7963	3843	76.3	23.25	19. 8.1948
8442	3980	57.6	17.55	13. 8.1948
8442	3980	57.3	17.45	9. 2.1831
8903	4674	39.9	12.15	13. 8.1948

Appendix I (d). Terrace fragment heights by use of the aneroid barometer.

The format for these results, identical with that in appendices I(a) and I(c), is

8 Figure National Grid Reference	Height (in feet)	Height (in metres)

and this is reproduced twice across each sheet. The procedure for obtaining the heights is set out in the text (Chapter 3) and involved the use of a 7 inch Paulin surveying aneroid, model Palbo.

F 626

7447	3519	103.2	31.45
7452	3521	102.7	31.30
7456	3524	99.2	30.25
7461	3527	98.7	30.10
7466	3529	100.2	30.55
7471	3532	97.7	29.80

F 630

7481	3549	121.2	36.95
7485	3553	120.2	36.65
7489	3557	118.2	36.05
7493	3560	119.7	36.50
7496	3563	118.2	36.05
7498	3567	118.2	36.05
7498	3570	116.2	35.40
7506	3591	123.2	37.55
7508	3595	123.2	37.55
7510	3599	121.2	36.95
7513	3603	115.2	35.10
7516	3606	118.2	36.05
7518	3610	112.2	34.20
7521	3614	110.2	33.60
7524	3618	115.2	35.10
7525	3623	114.2	34.80
7525	3628	110.2	33.60

F 632

7484	3548	112.2	34.20
7488	3550	109.2	33.30
7492	3552	107.2	32.65
7496	3554	108.2	33.00
7500	3556	109.2	33.30
7503	3569	106.2	32.35
7508	3572	106.2	32.35
7513	3574	108.2	33.00
7518	3576	109.2	33.30
7522	3578	106.2	32.35
7526	3580	106.2	32.35
7529	3584	107.2	32.65
7532	3588	106.2	32.35
7533	3593	105.2	32.05
7534	3598	105.2	32.05
7536	3603	107.2	32.65
7535	3608	102.2	31.15
7534	3613	97.2	29.65
7533	3618	92.2	28.10
7533	3623	97.2	29.65
7538	3624	97.2	29.65
7539	3628	101.2	30.85
7540	3633	102.2	31.15
7540	3638	97.2	29.65
7540	3642	97.2	29.65
7540	3647	97.2	29.65
7540	3651	92.2	28.10
7540	3656	93.2	28.40

F 634

7455	3525	99.7	30.40
7459	3527	101 .2	30.85
7463	3530	96.7	29.45
7467	3532	94.2	28.70
7471	3535	96.7	29.45

Appendix 2: Height/Distance Graph Coordinates for a sample of terrace fragments.

Section a).

The format of the data in this section is:

Distance along graph from arbitrary origin	Altitude in feet.

and this is repeated twice on each page. Metre equivalents of the terrace fragment heights can be obtained by refering to the corresponding terrace fragment data set out in appendix 1(a).

Section b).

This contains the results of calculations of linear correlation and regression between heights and distance between these heights on some sixty terrace fragments. These values were calculated by vari ants on an Atlas Autocode program entitled CORREG (Appendix 8). The meaning of all terms employed is set out in the relevant text (Chapter 9, section D).

FRAGMENT NO:40

X	Y(feet)
0.28	988.8
0.36	987.1
0.42	985.4
0.51	986.0
0.60	983.8
0.67	981.0
0.75	979.8
0.85	979.3
0.90	976.7
0.99	976.1
1.05	972.6
1.15	970.1
1.23	968.5
1.32	967.1
1.40	966.7
1.49	966.0
1.53	963.9
1.62	962.8
1.72	961.3
1.81	959.6
1.90	960.5
1.99	958.5
2.07	958.2

FRAGMENT NO:50

X	Y(feet)
0.59	918.8
0.65	917.0
0.72	915.8
0.79	914.6
0.86	913.2
0.93	911.6
1.00	909.5
1.08	908.3
1.14	906.6
1.22	905.2
1.30	904.3
1.37	903.7

FRAGMENT NO:60

X	Y (feet)
0.05	886.2
0.16	884.7
0.22	882.4
0.30	880.6
0.38	878.6
0.50	876.8
0.57	873.6
0.62	873.2
0.70	871.3
0.79	870.0

FRAGMENT NO:90

X	Y(feet)
0.20	813.2
0.30	813.2
0.36	813.7
0.45	812.4
0.51	810.8
0.60	810.5
0.66	808.8
0.75	808.4
0.85	809.1
0.92	807.7
1.00	806.3
1.08	804.7
1.14	802.7
1.22	799.3
1.30	797.3
1.37	796.7
1.45	796.5
1.50	795.4
1.56	795.5

FRAGMENT NO:106

X	Y(feet)
0.00	726.7
0.06	726.0
0.16	725.8
0.23	725.4
0.30	724.6
0.38	723.6
0.45	722.5
0.52	721.3
0.60	720.2
0.68	719.9
0.76	720.0
0.85	721.0
0.95	719.6
1.05	718.9
1.12	717.8
1.21	717.3
1.30	716.3
1.38	715.8
1.46	714.7
1.54	714.7
1.60	713.1
1.68	712.0
1.75	711.4
1.85	710.0
1.94	709.1
2.05	708.6

FRAGMENT NO:122

X	Y(feet)
0.08	749.4
0.13	746.6
0.19	744.3
0.24	741.2
0.29	738.8
0.32	737.0
0.39	736.1
0.40	734.0
0.45	734.0

FRAGMENT NO:124

X	Y(Feet)
0.40	776.9
0.48	769.6
0.55	763.6
0.62	758.0
0.70	750.5

FRAGMENT NO:126

X	Y(feet)
0.62	846.2
0.70	842.4
0.78	841.1
0.86	837.9
0.91	834.4
1.00	833.6
1.10	831.7

FRAGMENT NO:130

X	Y(feet)
0.00	661.9
0.09	661.0
0.15	660.6
0.23	660.4
0.30	659.3
0,40	659.7
0.47	658.5
0.54	658.1
0.62	657.0
0.70	655.8
0.78	655.7
0.84	655.6
0.91	654.3
1.00	654.1
1.07	653.1
1.18	652.7
1.24	652.3
1.33	651.9
1.46	651.5
1.55	651.0

FRAGMENT NO:130(cont'd.)

X	Y(feet)
1.63	650.5
1.72	649.7
1.80	650.1
1.87	648.3
1.95	648.6
2.01	647.7
2.08	647.4
2.18	647.0
2.22	646.2
2.29	645.9
2.36	646.2

FRAGMENT NO:150

X	Y(feet)
0.00	694.8
0.06	689.8
0.12	688.4
0.19	689.0
0.25	685.6
0.31	682.5
0.40	680.0
0.45	676.0
0.52	673.0
0.60	670.2
0.67	666.1
0.75	665.5

FRAGMENT NO:152

X	Y(feet)
0.50	641.7
0.58	639.9
0.68	639.2
0.75	638.0
0.80	636.7
0.89	636.2
0.95	635.2
1.02	635.2
1.10	633.0
1.18	632.5
1.27	630.0
1.34	630.1
1.40	628.4
1.48	627.1
1.58	626.5

FRAGMENT NO:154

X	Y(feet)
0.90	668.9
0.95	668.9
1.05	668.6
1.12	665.9
1.23	665.0
1.34	664.5
1.43	663.2
1.52	662.3
1.60	662.0
1.69	661.5
1.78	660.1
1.85	658.3
1.95	656.5
2.02	654.8
2.10	654.3
2.18	652.9
2.25	651.0
2.32	649.2
2.40	646.2
2.48	644.6
2.53	642.9
2.63	641.9
2.74	641.6

FRAGMENT NO:156

X	Y(feet)
0.40	661.0
0.45	659.8
0.50	659.2
0.56	656.8
0.65	654.8
0.72	653.2
0.80	652.2
0.88	652.7
0.92	651.2
0.99	649.7
1.02	648.7
1.10	647.6

FRAGMENT NO:177

X	Y(feet)
0.15	761.7
0.22	760.1
0.27	759.8
0.33	758.5
0.40	756.4
0.48	755.8
0.56	755.4
0.59	754.3
0.62	753.5
0.67	752.3
0.71	751.9
0.75	751.5

FRAGMENT NO:182

X	Y(feet)
0.58	587.7
0.65	587.8
0.72	587.4
0.80	587.7
0.86	587.3
0.93	586.6
1.01	586.2
1.10	585.5
1.18	585.2
1.24	584.7
1.33	584.2
1.41	584.2
1.47	584.7
1.54	584.8
1.63	584.6
1.70	584.4
1.78	584.2
1.87	584.3
1.95	583.8
2.02	583.4
2.10	582.3
2.18	582.0
2.24	581.6
2.36	581.3
2.45	579.9

FRAGMENT NO:183

X	Y(feet)
0.54	740.9
0.62	739.5
0.71	738.6
0.80	737.9
0.89	737.2
0.99	736.1
1.09	735.4
1.18	732.5
1.28	731.2
1.37	728.9
1.46	727.4
1.55	725.3
1.65	726.3

FRAGMENT NO:189

X	Y(feet)
0.99	704.4
1.07	703.1
1.16	701.9
1.25	701.2
1.35	701.2
1.43	700.3
1.50	698.9
1.59	698.8
1.65	698.1
1.77	697.2
1.85	696.9
1.93	696.4
2.02	695.3
2.12	694.1
2.22	692.7
2.31	691.3
2.40	691.5
2.51	690.6
2.60	689.9
2.69	688.5
2.79	687.6
2.89	687.7
2.97	686.4
3.05	686.0
3.12	685.3
3.21	684.3
3.30	684.1
3.38	683.1
3.45	682.6
3.52	682.4
3.60	681.5
3.68	681.0
3.75	680.0
3.84	680.2
3.91	679.3
4.00	678.0
4.09	677.8
4.16	678.0
4.22	676.6
4.32	675.2
4.45	675.2

FRAGMENT NO:203(B2)

X	Y(feet)
0.50	615.3
0.57	614.8
0.65	614.5
0.72	613.2
0.80	612.9
0.88	612.3
0.95	612.7
1.02	612.5
1.10	612.5
1.20	612.6
1.29	612.5
1.38	612.3
1.45	612.1
1.60	612.4
1.68	612.6
1.74	611.4
1.82	610.8
1.90	610.3
1.97	610.1
2.02	610.1
2.10	609.4
2.18	609.7
2.25	608.4
2.32	608.7
2.40	608.5
2.48	608.2
2.55	607.4
2.64	607.4
2.71	607.3
2.79	607.2
2.86	606.7
2.95	605.3
3.02	604.3
3.10	605.2
3.18	604.5
3.25	604.1
3.32	603.4
3.42	603.2
3.50	602.4
3.58	602.3
3.65	602.5
3.75	602.5
3.85	602.3
3.95	601.1
4.05	601.5
4.12	601.0
4.22	600.1
4.30	598.7
4.39	598.9
4.49	598.3
4.56	596.9
4.65	595.3
4.72	596.1

FRAGMENT NO:203(B2)(Cont'd.)

X	Y(feet)
4.81	595.8
4.91	595.9
5.02	595.8
5.12	596.9
5.20	597.1
5.28	596.8
5.35	596.8
5.42	596.7
5.51	595.8
5.59	594.8
5.68	594.3
5.75	593.9
5.83	594.6
5.95	594.3
6.01	594.3
6.07	593.8
6.12	593.4
6.20	593.4
6.25	592.8
6.31	591.9
6.39	592.6
6.45	592.1
6.52	591.9
6.56	590.4
6.64	589.6
6.74	589.7
6.83	589.6
6.90	589.0
7.00	588.8

FRAGMENT NO:203(B3)

X	Y(feet)
0.65	628.2
0.71	624.9
0.80	625.3
0.87	624.5
0.95	624.3
1.02	623.7
1.10	622.9
1.18	622.3
1.25	622.5
1.31	621.8
1.40	621.9
1.48	621.5
1.58	624.3
1.66	622.8
1.76	621.5
1.85	621.4
1.91	622.0
1.97	621.7
2.02	621.1
2.10	620.8
2.16	620.8

FRAGMENT NO:207

X	Y(feet)
0.31	685.1
0.35	682.2
0.40	679.2
0.45	677.6
0.50	674.5
0.56	672.7
0.60	670.9
0.65	666.7
0.71	662.6
0.76	660.5
0.81	658.9
0.86	656.7
0.90	653.3
0.95	650.0

FRAGMENT NO:208W

X	Y(feet)
0.80	629.6
0.89	628.4
0.98	627.5
1.05	626.7
1.13	626.0
1.20	623.2
1.27	621.3
1.35	620.3
1.40	619.4
1.56	617.0
1.60	615.2
1.66	614.4
1.71	612.7
1.75	610.9
1.84	608.8
1.90	607.2
1.96	606.5

FRAGMENT NO:212

X	Y(feet)
0.95	708.6
1.03	706.7
1.09	703.9
1.15	701.2
1.22	698.2
1.28	695.6

FRAGMENT NO:216

X	Y(feet)
0.20	645.6
0.25	643.9
0.37	641.4
0.45	638.6
0.54	638.3
0.60	635.4
0.69	633.6
0.76	630.2
0.83	626.7
0.92	625.0
1.05	623.3

FRAGMENT NO:313

X	Y(feet)
2.64	479.7
2.53	477.4
2.42	475.8
2.36	474.2
2.30	472.4
2.21	470.7
2.14	467.6
2.09	465.9
2.02	464.1
1.99	462.1
1.90	461.3
1.80	460.9
1.73	461.1
1.64	459.2

FRAGMENT NO:350

X	Y(feet)
0.55	467.2
0.62	466.0
0.70	466.9
0.79	465.5
0.85	463.6
0.91	462.9
0.96	464.6
1.03	463.2
1.09	461.4
1.15	460.1

FRAGMENT NO:364

X	Y(feet)
0.06	536.8
0.14	536.5
0.22	534.4
0.30	532.9
0.42	532.4
0.51	533.9

FRAGMENT NO:368 & 372

X	Y(feet)
0.80	468.2
0.87	467.3
0.95	466.2
1.00	462.4
1.07	460.6
1.14	456.8
1.22	454.3
1.30	452.3
1.38	449.8
1.42	448.7
1.50	446.0
1.54	443.5

FRAGMENT NO:370

X	Y(feet)
0.66	402.3
0.74	401.8
0.82	401.9
0.88	400.3
0.95	400.7
1.01	400.9
1.10	401.3
1.18	401.7
1.25	402.3
1.32	401.8
1.39	401.5
1.48	401.3
1.53	401.3
1.58	400.0
1.66	399.5
1.74	398.8
1.79	398.9
1.83	397.9
1.87	397.4
1.89	395.9
1.93	395.5

FRAGMENT NO:373

X	Y(feet)
0.64	371.1
0.72	371.3
0.81	371.3
0.90	368.4
1.01	367.3
1.10	367.9
1.20	366.5
1.30	364.8
1.40	362.7

FRAGMENT NO:392

X	Y(feet)
0.01	371.9
0.10	369.9
0.22	370.5
0.35	369.8
0.50	368.2
0.56	367.4
0.62	368.3
0.75	369.3

FRAGMENT NO:394

X	Y(feet)
0.70	348.5
0.77	348.9
0.82	347.7
0.90	347.2
0.98	346.3
1.05	347.7
1.12	347.8
1.19	347.2
1.28	346.9
1.32	346.0
1.40	346.0
1.48	346.0
1.55	344.4
1.62	343.8
1.70	344.1
1.80	344.2
1.87	343.5
1.92	340.9
1.99	339.9
2.06	339.9
2.13	341.3
2.21	339.4
2.30	340.1

FRAGMENT NO:398

X	Y(feet)
1.73	339.3
1.80	339.2
1.90	338.5
1.97	338.3
2.05	338.5
2.10	338.0
2.18	337.1
2.25	337.3
2.34	336.6
2.42	335.7
2.51	335.8
2.59	336.6
2.65	335.8
2.74	335.1

FRAGMENT NO:398 (cont'd.)

X	Y(feet)
2.81	333.8
2.90	333.0
2.99	333.5
3.09	333.7
3.17	332.8
3.25	332.4
3.32	331.9
3.40	333.3
3.49	332.8
3.56	331.1
3.65	333.0
3.74	331.5
3.84	330.1
3.90	331.0
3.99	331.1
4.02	330.1
4.05	329.3
4.12	329.3
4.20	329.1
4.24	328.1
4.31	328.9
4.34	328.8
4.38	327.2
4.42	325.4
4.50	325.6

FRAGMENT NO:412

X	Y(feet)
0.45	385.4
0.50	386.0
0.58	385.7
0.65	384.8
0.71	386.3
0.78	385.7
0.80	383.4
0.90	383.2

FRAGMENT NO:428

X	Y(feet)
0.62	405.8
0.70	407.0
0.79	406.7
0.88	406.9
0.96	407.9
1.02	409.0
1.10	410.4
1.19	410.0
1.30	410.0

FRAGMENT NO:582

X	Y(feet)
0.7	154.3
1.0	153.0
1.3	152.2
1.6	152.9
1.9	153.2
2.3	152.5
2.6	152.3
2.9	151.4
3.2	150.9
3.4	150.5
3.7	150.3
3.9	149.3
4.1	147.8
4.3	147.5
4.5	147.0
4.7	147.1
5.0	148.3
5.2	146.8
5.5	146.7
5.7	146.2
5.8	146.7
6.0	146.2
6.1	145.9
6.3	144.8
6.5	144.3
6.6	146.6
6.8	143.3
6.9	143.3
7.0	144.0
7.1	142.8
7.2	142.7
7.3	142.0
7.4	142.0
7.6	143.0
7.7	140.9
7.8	141.0
7.9	141.8
8.0	141.0
8.1	141.3
8.2	141.9
8.3	142.0
8.4	142.3
8.5	142.0
8.6	140.6
8.7	139.4
8.8	138.0
8.9	138.9
9.0	138.3
9.1	139.6
9.2	141.2
9.3	141.1
9.4	140.4
9.5	140.2

FRAGMENT NO:582(cont'd.)

X	Y(feet)
9.6	138.5
9.7	136.9
9.8	135.9
9.9	136.6
10.0	137.4
10.1	138.2
10.2	138.2
10.3	137.7

FRAGMENT NO:629

X	Y(feet)
0.6	123.9
0.8	123.3
0.9	123.2
1.1	123.0
1.2	122.3
1.4	121.0
1.5	120.8
1.7	118.9

FRAGMENT NO:630

X	Y(feet)
3.5	114.2
3.9	112.6
4.4	109.7
4.8	111.8
5.3	112.7
5.7	112.7
6.1	112.2
6.4	111.5
7.8	106.2
8.2	107.6
8.6	105.8
9.0	106.2
9.4	106.2
9.8	106.0
10.2	105.7
10.6	106.2
11.0	106.1
11.4	104.7
11.8	104.3
12.1	105.6
12.4	106.4
12.7	102.7

FRAGMENT NO:632

X	Y(feet)
3.5	102.1
3.8	102.1
4.1	102.1
4.4	101.2
4.7	100.7
5.0	100.7
5.3	100.8
5.6	100.1
5.9	99.3
6.3	98.7
6.7	99.3
7.1	99.6
7.5	100.2
7.9	99.2
8.3	100.5
8.7	101.2
9.1	100.9
9.5	101.0
9.9	100.5
10.3	100.3
10.7	98.3
11.1	93.9
11.6	93.6
12.0	94.3
12.4	94.3
12.8	94.6
13.2	94.0
13.6	93.0
14.0	92.0
14.4	90.6
14.8	91.0
15.2	90.4
15.6	90.5
16.0	90.5

FRAGMENT NO:679

X	Y(feet)
0.3	178.9
0.4	178.2
0.6	178.0
0.8	178.2
0.9	177.9
1.1	176.8
1.3	176.4
1.5	174.8
1.7	173.1
1.8	171.6
2.0	170.7
2.2	169.7
2.3	169.2
2.5	168.5
2.9	164.0

FRAGMENT NO:679(cont'd.)

X	Y(feet)
3.1	167.5
3.4	168.4
3.7	167.3
4.0	165.5
4.3	163.4
4.6	162.0
4.9	162.4
5.2	162.1
5.5	160.3
5.8	159.6
6.1	158.3
6.4	159.2
6.7	159.7
7.0	158.2

FRAGMENT NO:687, 707 & 719

X	Y(feet)
0.1	90.8
0.3	90.4
0.4	90.0
0.6	89.3
0.8	89.6
0.9	87.7
1.1	85.8
1.2	84.7
1.4	84.8
1.7	84.6
1.8	85.5
1.9	85.1
2.0	83.4
2.1	82.9
2.4	82.3
2.7	81.5
3.0	80.8
3.3	81.5
3.9	81.6
4.2	81.7
4.5	81.3
4.8	80.9
5.1	79.9
5.3	77.7
5.4	76.5
5.5	74.5
5.6	73.9
5.7	74.0
5.8	73.9
5.9	74.1
6.0	74.2
6.2	75.5
6.4	76.3
6.5	74.7
6.6	73.6

FRAGMENT NO:687,707&719(cont'd.)

X	Y(feet)
6.8	73.3
6.9	72.1
7.0	71.0
7.2	70.7
7.3	70.6
7.4	71.1
7.6	71.9
7.7	72.0
7.8	70.9
8.0	71.1
8.1	72.5
8.2	72.6
8.4	73.6
8.5	71.6
8.6	71.9
8.7	71.8
8.9	70.0
9.1	69.9
9.2	70.8
9.4	69.3
9.5	68.5
9.6	68.6
9.7	68.2
9.9	66.8
10.1	67.3
10.2	67.2
10.3	66.3
10.4	67.5
10.6	69.9
10.7	68.5
10.8	69.1
10.9	67.5
11.0	66.6
11.1	68.7
11.3	70.3
11.4	68.8
11.5	68.0
11.6	66.0
11.7	63.5
11.8	62.6
11.9	63.4
12.0	64.9
12.1	65.1

FRAGMENT NO:689

X	Y(feet)
0.1	91.1
0.2	89.4
0.3	86.8
0.4	84.6
0.5	84.1
0.6	81.9
0.7	81.7
0.8	80.9

FRAGMENT NO:714

X	Y(feet)
0.9	42.8
1.1	42.9
1.3	42.7
1.5	42.5
1.7	42.4
1.9	42.2
2.1	41.7
2.3	40.7
2.5	40.3
2.7	40.0
2.9	40.9

FRAGMENT NO:720

X	Y(feet)
0.2	41.3
0.4	40.0
0.6	40.6
0.8	37.5
1.0	38.0
1.2	37.9
1.4	38.0
1.6	37.6
1.7	34.2
1.9	35.5
2.2	36.2
2.4	33.5

FRAGMENT NO:722

X	Y(feet)
0.6	33.1
0.8	32.9
1.0	33.4
1.2	32.9
1.4	32.5

FRAGMENT NO:728

X	Y(feet)
0.9	32.6
1.1	32.0
1.2	31.9
1.3	32.0
1.4	32.0
1.6	32.2
1.7	32.3
1.9	32.0
2.0	33.4
2.1	34.0
2.3	33.7
2.4	34.2
2,5	34.5
2.7	34.8
2.8	35.0
2.9	35.2

FRAGMENT NO:740

X	Y(feet)
0.4	121.3
0.5	120.0
0.6	119.4
0.8	118.2
0.9	117.0
1.0	115.7
1.1	114.0
1.2	111.5
1.3	110.8
1.4	109.0
1.5	107.1
1.6	105.2
1.7	103.2
1.8	102.8
1.9	100.4
2.0	98.3
2.1	97.0

FRAGMENT NO:742

X	Y(feet)
0.1	145.9
0.2	144.3
0.3	141.7
0.4	141.8
0.5	138.4
0.6	136.1
0.6	133.0
0.7	130.4
0.8	127.7
0.9	124.6
0.9	121.9
1.0	121.6
1.1	119.6
1.1	119.2
1.2	119.2

FRAGMENT NO:752

X	Y(feet)
0.0	22.2
0.2	22.3
0.4	21.9
0.6	21.4
0.8	22.2
1.0	22.0
1.2	22.7
1.4	23.0
1.6	23.2
1.8	23.4
2.0	23.3
2.2	24.8
2.4	23.7
2.6	23.9
2.9	24.5

FRAGMENT NO:776

X	Y(feet)
0.6	23.6
0.8	22.1
1.0	21.8
1.2	22.5
1.4	22.6
1.6	22.5
1.8	21.9
2.0	21.7
2.2	21.1

FRAGMENT NO:783

X	Y(feet)
0.5	94.7
0.7	94.9
0.8	94.2
0.9	93.8
1.1	93.2
1.2	92.4
1.2	91.6
1.4	87.8
1.5	86.2
1.6	84.5
1.7	83.4

FRAGMENT NO:791

X	Y(feet)
0.7	38.7
0.9	37.9
1.1	38.2
1.3	38.2
1.4	38.4
1.6	38.1
1.8	39.1
2.0	39.0
2.2	39.2
2.4	38.3

FRAGMENT NO:793 & 738

X	Y(feet)
0.4	94.9
0.6	97.1
0.9	96.1
1.1	95.8
1.4	95.4
1.7	94.9
1.9	92.4
2.1	92.5
2.3	93.1
2.5	91.5
2.6	88.8
2.7	86.9
2.9	88.9
3.0	87.3
3.1	87.2
3.3	87.0
3.4	86.4
3.5	85.7
3.7	85.3
3.8	82.4
4.4	82.9
4.7	83.6
4.9	82.5
5.1	81.5
5.4	80.0
5.6	78.9
5.8	78.5
6.1	77.5
6.3	75.9
6.5	75.1
6.8	74.2

FRAGMENT:NO:806T

X	Y(feet)
0.1	15.9
0.3	17.7
0.5	17.7
0.7	17.7
0.9	18.2
1.1	17.8
1.3	17.0
1.5	16.6
1.7	16.4
1.9	16.2
2.1	16.0
2.3	16.5
2.5	15.9
2.7	15.3
2.8	15.1
3.0	14.8
3.2	13.9

FRAGMENT NO:806T(cont'd.)

X	Y(feet)
3.4	13.3
3.6	13.4
3.8	13.5
3.9	13.4
4.1	13.3
4.2	13.1
4.4	12.7
4.6	12.9
4.7	13.5

FRAGMENT NO:806W

X	Y(feet)
0.1	16.0
0.3	16.2
0.5	16.1
0.6	14.8
0.8	12.2
1.0	13.8
1.1	13.5
1.3	12.8
1.5	13.3
1.6	13.6
1.8	13.7
2.0	13.5
2.1	12.5
2.3	12.1
2.4	11.7
2.6	11.1
2.7	10.0
2.9	9.9
3.1	11.6
3.3	12.1
3.5	11.6
3.7	11.3
3.9	10.6
4.2	9.4
4.4	9.3

FRAGMENT NO.818

X	Y(feet)
0.1	52.1
0.3	50.2
0.5	50.3
0.7	48.9
0.9	48.6
1.1	48.7
1.3	49.0
1.6	48.0
1.8	46.6
2.1	47.3

FRAGMENT NO:818(cont'd.)

X	Y(feet)
2.3	47.5
2.5	46.3
2.8	47.2
3.0	46.0
3.2	44.6
3.4	43.8
3.6	42.9

FRAGMENT NO:819

X	Y(feet)
0.5	46.4
1.2	47.2
1.5	46.4
1.7	46.2
1.9	45.9
2.0	45.9
2.1	45.6
2.2	44.7
2.4	45.1
2.5	45.9
2.6	44.1
2.8	47.1
3.0	46.2
3.2	45.1
3.7	45.5
3.9	42.5
4.0	40.6
4.2	41.3
4.4	42.6
4.6	42.5
4.9	41.1
5.0	38.8
5.1	39.5
5.3	41.1
5.5	41.5
5.7	42.3
5.8	42.4
6.0	41.0
6.2	40.2
6.3	39.9

FRAGMENT NO:821

X	Y(feet)
0.6	25.3
0.8	26.2
0.9	26.1
1.1	26.3
1.2	26.1
1.4	26.6
1.6	27.5
1.7	27.7

FRAGMENT NO:821(cont'd.)

X	Y(feet)
1.8	27.8
2.0	28.0
2.2	27.7
2.4	27.5
2.6	28.8
2.7	30.5
2.9	30.2
2.9	30.2
3.1	30.8
3.2	30.6
3.4	30.7
3.5	30.3
3.6	30.1
3.8	31.1
4.0	31.6

FRAGMENT NO:826

X	Y(feet)
0.3	9.3
0.4	9.5
0.6	9.2
0.8	9.2
1.0	9.2
1.3	9.6
1.4	8.8
1.5	7.5
1.7	7.8
2.0	8.9
2.2	8.3
2.4	8.3
2.5	8.8
2.7	9.2
2.9	9.4

FRAGMENT NO:829

X	Y(feet)
0.8	28.8
1.0	26.6
1.2	26.1
1.4	25.6
1.7	25.0
1.9	24.6
2.1	24.5
2.4	24.5
2.6	24.5
2.8	26.0
2.9	26.6
3.1	27.0
3.2	27.0
2.4	27.3
3.5	27.6

FRAGMENT NO:829(cont'd.)

X	Y(feet)
3.6	28.2
3.7	27.4
3.9	27.7
4.0	27.8
4.2	28.1
4.3	27.8
4.5	27.6
4.7	27.8
4.8	27.5
4.9	27.1
5.1	26.5
5.2	26.8
5.4	26.8
5.5	27.0
5.7	25.4
5.8	24.1
6.0	23.8
6.1	24.3
6.3	25.1
6.5	25.2
6.7	25.0
6.9	24.5
7.1	24.8
7.3	24.2
7.5	22.6
7.7	22.9
7.8	23.4
7.9	24.6
8.0	25.0
8.1	25.4
8.2	26.6

FRAGMENT NO:831

X	Y(feet)
0.0	44.1
0.2	42.9
0.4	43.8
0.7	46.5
0.9	48.1
1.2	48.8
1.4	47.5
1.7	45.2
1.9	43.8
2.2	42.0
2.5	41.1
2.7	39.4
2.9	40.6
3.1	41.5
3.3	41.6
3.5	40.0
3.9	34.9
4.2	32.7

FRAGMENT NO:831(cont'd.)

X	Y(feet)
4.5	34.2
4.7	35.7
4.8	36.3
5.0	35.0
5.1	34.3
5.2	33.7
5.3	32.5

FRAGMENT NO:841

X	Y(feet)
0.3	20.8
0.4	20.2
0.5	19.9
0.7	19.4
0.9	19.7
1.0	19.9
1.1	18.3
1.3	19.0
1.5	19.0
1.7	19.2
1.9	19.1
2.1	18.1
2.3	18.4
2.5	18.9
2.7	19.3
2.9	18.0
3.1	19.4
3.3	19.5
3.4	18.8
3.6	18.4
3.8	18.5
3.9	17.6

FRAGMENT NO:843 & 853

X	Y(feet)
0.7	18.3
0.9	16.3
1.5	16.7
1.8	16.6
2.0	16.3
2.3	16.6
2.5	17.1
2.7	17.5
2.9	16.2
3.2	16.1
3.4	16.3
3.5	15.5
3.7	15.1
3.8	15.2
4.0	14.3
4.2	14.8

FRAGMENT NO:843 &853 (cont'd.)

X	Y(feet)
4.3	15.3
4.5	15.6
4.7	14.6
4.9	14.4
5.0	14.6
5.2	14.1
5.3	14.5
5.5	14.6
5.6	14.8
5.8	14.2
5.9	14.5
6.1	15.0
6.2	14.5
6.3	14.6
6.5	14.1
6.6	14.4
6.8	14.6
6.9	14.6
7.1	14.2
7.3	13.1
7.5	13.4
7.7	13.7
7.9	12.5
8.0	13.3
8.2	12.4

FRAGMENT NO:845

X	Y(feet)
0.6	107.9
1.2	107.5
1.5	106.2
1.8	104.3
2.4	102.6
3.0	100.4
3.3	97.8
3.7	94.9
4.0	93.1
4.4	91.7
4.8	90.2
5.1	89.7
5.5	90.7
5.8	90.2
6.2	91.0
6.5	91.0
6.9	90.8
7.2	90.9

FRAGMENT NO:847

X	Y(feet)
0.5	52.9
0.7	53.5
0.9	52.5
1.1	51.7
1.3	52.4
1.5	53.0
1.7	54.0
1.9	54.1
2.1	54.6
2.3	54.3
2.5	54.1
2.7	51.6
2.9	51.0
3.0	49.6
3.2	48.1
3.4	46.5
3.6	45.6
3.8	46.0
4.0	46.5
4.2	46.3
4.3	45.7
4.5	43.7
4.6	42.2

Terrace No.	$B_{2_1}-B_{2_2}$	$A_{2_1}-A_{2_2}$	$B_{5_{max}}-B_{5_{min}}$	%B $Varn_2$	%B $Varn_3$	%B $Varn_4$	%B $Varn_5$	N_1	N_{2_1}	N_{3_1}	N_{4_1}	N_{5_1}	r_1
40	0.30	0.70	0.75	1.8	7.8	13.4	4.1	23	11	7	5	4	0.99
50	0.51	0.31	0.42	4.0	8.6	10.3	5.2	12	6	4	3	2	1.00
60	0.24	0.64	2.91	1.8	5.4	0.0	9.3	10	5	3	2	2	1.00
90	1.54	1.42	4.95	5.1	8.5	30.5	42.5	19	9	6	4	3	0.97
106	0.05	0.11	0.26	0.4	2.8	4.9	3.9	26	13	8	6	5	0.99
122	3.18	0.03	-	1.8	0.8	16.4	-	9	4	3	2	-	0.99
124	5.81	3.00	-	1.8	-	-	-	5	2	-	-	-	1.00
126	11.06	8.66	-	30.6	12.0	-	-	7	3	2	-	-	0.98
130	0.23	0.29	0.24	0.7	0.3	0.3	6.0	31	15	10	7	6	0.99
150	3.27	1.00	5.11	4.3	3.6	5.4	0.4	12	6	4	3	2	0.99
152	0.93	0.56	1.15	4.6	1.6	2.3	7.2	15	7	5	3	3	1.00
154	0.26	0.44	2.37	1.7	10.8	17.7	22.2	23	11	7	5	4	0.98
156	1.52	2.10	5.89	6.0	3.2	1.6	31.9	12	6	4	3	2	0.99
177	0.35	0.27	2.21	0.7	1.8	3.7	5.8	12	6	4	3	2	0.99
182	0.02	0.09	0.18	5.3	6.7	3.8	5.1	25	12	8	6	5	0.96
183	1.45	1.09	3.61	2.9	4.3	9.2	26.3	13	6	4	3	2	0.98
189	0.08	0.21	0.32	0.9	0.2	3.2	4.2	41	20	13	10	8	1.00
203	0.01	0.05	0.09	0.2	0.2	0.3	2.4	82	41	27	20	16	0.99
203	1.19	2.28	2.27	19.0	24.9	23.5	74.0	21	10	7	5	4	0.82

207	0.52	0.39	5.50	0.5	1.3	6.0	6.5	14	7	4	3	2	1.00
208	0.68	0.96	2.08	2.5	10.9	8.6	13.4	17	8	5	4	3	0.99
212	5.92	7.00	-	5.6	9.1	-	-	6	3	2	-	-	1.00
216	0.65	0.90	4.08	3.5	11.4	22.4	7.8	11	5	3	2	2	0.99
313	0.83	1.70	5.89	1.9	19.7	11.4	6.8	14	7	4	3	2	0.98
350	0.25	0.24	4.04	3.2	40.7	11.4	10.9	10	5	3	2	2	0.93
364	5.70	0.89	-	40.7	88.5	-	-	6	3	2	-	-	0.80
368 & 372	0.20	0.59	1.46	1.4	6.1	6.9	1.8	12	6	4	3	2	1.00
370	0.59	0.33	0.86	20.9	23.9	45.0	30.1	21	10	7	5	4	0.79
373	0.71	0.62	-	13.1	25.9	6.8	-	9	4	3	2	-	0.96
392	4.36	1.88	-	49.9	44.7	77.0	-	8	4	2	2	-	0.78
394	1.22	1.62	1.87	3.6	2.9	31.3	32.3	23	11	7	5	4	0.95
398	0.15	0.83	0.16	5.5	4.3	10.2	2.1	39	19	13	9	7	0.98
412	1.57	1.12	-	16.9	37.3	27.7	-	8	4	2	2	-	0.64
428	2.42	2.09	-	31.3	34.5	11.8	-	9	4	3	2	-	0.93
582	0.01	0.01	0.10	0.0	0.4	1.3	4.9	61	30	20	15	12	0.98
629	1.67	1.76	-	20.9	58.1	37.9	-	8	4	2	2	-	0.95
630				7.0	14.8	18.4	25.9	22	11	7	5	4	0.91
632				1.3	3.2	13.9	31.6	34	17	11	8	6	0.91
679	0.12	0.22	0.42	4.7	10.1	11.5	23.5	29	14	9	7	5	0.97

687, 707 & 719	0.01	0.16	0.02	0.4	0.6	0.9	0.2	79	39	26	19	15	0.97
689	1.35	0.86	-	3.7	45.5	17.5	-	8	4	2	2	-	0.98
714	0.40	0.74	1.10	1.2	38.1	66.3	59.5	11	5	3	2	2	0.92
720	0.35	0.90	0.75	4.1	3.2	54.4	11.3	12	6	4	3	2	0.90
722			-	25.0	-	-	-	5	2	-	-	-	0.58
728	0.41	0.92	0.93	10.4	17.8	24.7	55.5	16	8	5	4	3	0.91
740	0.57	0.78	1.48	3.2	5.3	6.0	13.7	17	8	5	4	3	0.99
742	1.69	2.15	0.95	1.3	0.9	8.5	3.4	15	7	5	3	3	0.96
752	0.42	0.50	0.42	23.5	14.0	35.5	43.2	15	7	5	3	3	0.89
776	0.77	1.14	-	17.3	54.5	36.4	-	9	4	3	2	-	0.71
783	3.55	3.93	6.29	23.6	58.3	75.8	68.2	11	5	3	2	2	0.93
791	0.08	0.39	0.33	34.8	15.1	12.2	74.6	10	5	3	2	2	0.47
793 & 738	0.19	0.64	0.26	3.0	8.5	6.2	7.5	31	15	10	7	6	0.98
806 T	0.14	0.58	.40	5.4	19.3	19.4	30.1	26	13	8	6	5	0.93
806 W	0.12	0.32	0.15	4.9	3.5	10.1	0.9	25	12	8	6	5	0.88
818	0.15	0.88	0.36	3.4	16.8	9.4	3.4	17	8	5	4	3	0.95
819	0.21	0.94	0.34	7.5	0.2	4.4	24.5	30	15	10	7	6	0.87
821	0.05	0.19	0.14	1.3	5.7	15.9	11.2	23	11	7	5	4	0.96
826	0.16	0.05	0.30	114.0	13.4	422.5	149.2	15	7	5	3	3	0.28
829	0.07	0.34	0.25	11.0	46.2	48.9	86.7	46	23	15	11	9	0.44
831	0.19	0.56	0.59	5.4	6.6	8.3	22.3	25	12	8	6	5	0.90

841	0.13	0.04	0.64	16.4	28.1	27.2	138.8	22	11	7	5	4	0.66
843 & 853	.09	0.45	0.19	5.9	6.3	2.0	31.0	41	20	13	10	8	0.91
845	0.16	0.54	0.53	2.6	4.6	22.7	35.9	18	9	6	4	3	0.93
847	0.39	0.81	0.44	14.1	24.7	23.0	30.5	23	11	7	5	4	0.86

Appendix 3 Trend surface results.

The symbols employed in this appendix are used in the following manner: C1 to C9 are the coefficients of the terms in the first and second order equations for the trend surfaces fitted to a fragment or combination of fragments. The equations are thus

$$Z = C1 + C2X + C3Y$$

$$Z = C4 + C5X + C6Y + C7X^2 + C8Y^2 + C9XY$$

where Z, the dependent variable, represents terrace height at points whose coordinates are X and Y. The power factor of each coefficient is written immediately after it. N is the number of heights in the calculation while S is the standard deviation of the Z values and r is the correlation coefficient. N.G. represents National Grid coordinates while R represents coordinates measured relative to a line round the rear of the fragment.

The symbols used in section C are explained in the covering text, Chapter 11 (Section D).

A. Surfaces fitted to individual fragments

1. F 584 (N.G.) Rectangular grid over whole terrace

1st. degree	2nd. degree
C1 = .770401 + 03	C4 = .347124 + 04
C2 = -.358252 - 01	C5 = -.762977 + 01
C3 = -.114316 + 00	C6 = .141854 + 02
	C7 = .196180 - 03
	C8 = -.362980 - 02
	C9 = .143608 - 02
r = 0.8624	r = 0.8697
S = 0.87	S = 0.85
N = 58	

2. F 584 (R) Heights all over fragment

1st. degree	2nd. degree
C1 = .145270 + 03	C4 = .789047 + 02
C2 = -.330433 - 00	C5 = .263289 + 01
C3 = -.351679 - 00	C6 = .707863 + 01
	C7 = -.352650 - 01
	C8 = -.301802 - 00
	C9 = -.131896 - 00
r = .8287	r = .8904
S = .98	S = .80
N = 58	

3. F 585 (N.G.) Heights around rim and cross traverses

1st. degree	2nd. degree
C1 = .707757 + 03	C4 = .602690 + 05
C2 = -.930002 - 01	C5 = -.178032 + 02
C3 = .238455 - 01	C6 = .114310 + 01
	C7 = .963230 - 03
	C8 = -.150096 - 02
	C9 = .129251 - 02

r = .9610	r = .9796
S = 1.17	S = .80
N = 59	

4. F 585 (N.G.) Heights on rectangular grid over whole fragment

1st. degree	2nd. degree
C1 = .742396 + 03	C4 = .341197 + 05
C2 = -.911845 - 01	C5 = -.646539 + 01
C3 = .941784 - 02	C6 = -.678488 + 01
	C7 = .787800 - 04
	C8 = -.631990 - 03
	C9 = .158796 - 02
r = .9175	r = .9381
S = 1.37	S = 1.19
N = 177	

5. F 585 (R) Heights all over fragment

1st. degree	2nd. degree
C1 = .146795 + 03	C4 = .148204 + 03
C2 = -.612422 - 00	C5 = -.931655 - 00
C3 = .500470 - 00	C6 = .660369 - 00
	C7 = .121948 - 01
	C8 = -.117444 - 01
	C9 = .206453 - 02
r = .9547	r = .9616
S = 1.04	S = .96
N = 177	

6. F585 (R) Upstream half only - heights all over surface

1st. degree	2nd. degree
C1 = .147800 + 03	C4 = .147394 + 03
C2 = -.729936 - 00	C5 = -.683208 - 00
C3 = .496390 - 00	C6 = .916406 - 00
	C7 = .412525 - 03
	C8 = .258145 - 01
	C9 = -.534205 - 01

r = .9275	r = .9297
S = .88	S = .87
N = 85	

7. F 585 (R) Downstreat end only - heights all over surface

1st. degree	2nd. degree
C1 = .143791 + 03	C4 = .141173 + 03
C2 = -.445746 - 00	C5 = -.257863 - 00
C3 = .748954 - 00	C6 = .194033 + 01
	C7 = -.265077 - 02
	C8 = -.456037 - 01
	C9 = -.579585 - 01
r = .9015	r = .9058
S = .95	S = .93
N = 92	

8. F 585 (N.G.) Rectangular grid within 1 Km. square 69/33 only

1st. degree	2nd. degree
C1 = .607020 + 03	C4 = .520920 + 05
C2 = -.940657 - 01	C5 = -.884778 + 01
C3 = .560747 - 01	C6 = -.126116 + 02
	C7 = .667384 - 03
	C8 = .206895 - 02
	C9 = -.157394 - 03
r = .9178	r = .9429
S = .99	S = .83
N = 145	

9. F 585 (N.G.) Clustered data layout within 1 Km. square 69/33

1st. degree	2nd. degree
C1 = .587091 + 03	C4 = .343715 + 05
C2 = -.105620 + 00	C5 = -.736266 + 01
C3 = .891744 - 01	C6 = -.506015 + 01
	C7 = .289802 - 03
	C8 = -.238467 - 03
	C9 = .969394 - 03

r = .9280		r = .9385
S = 1.01		S = .94
N = 58		

10. F 585 (N.G.) Random data layout within 1 Km. square 69/33

1st. degree	2nd. degree
C1 = .597434 + 03	C4 = .479391 + 05
C2 = -.907843 - 01	C5 = -.132572 + 02
C3 = .520836 - 01	C6 = -.906630 - 00
	C7 = .613184 - 03
	C8 = -.130598 - 02
	C9 = .139222 - 02
r = .9290	r = .9652
S = .88	S = .62
N = 90	

11. F 586/588 (N.G.) Rectangular gridded data

1st. degree	2nd. degree
C1 = .292311 + 02	C4 = -.297386 + 06
C2 = -.465676 - 01	C5 = .713856 + 02
C3 = .126198 - 00	C6 = .274869 + 02
	C7 = -.524222 - 02
	C8 = -.484845 - 02
	C9 = .725080 - 03
r = .4971	r = .8037
S = 1.65	S = 1.13
N = 48	

12. F 586/588 (R) Data all over surface - distorted rectangular grid

1st. degree	2nd. degree
C1 = .116004 + 03	C4 = .732303 + 02
C2 = .694857 - 01	C5 = .311235 + 01
C3 = .144352 + 01	C6 = .987458 - 00
	C7 = -.565820 - 01
	C8 = -.313548 - 00
	C9 = .833755 - 01

r = .6882
S = 1.38
N = 48

r = .8091
S = 1.12

B. Surfaces fitted to combinations of fragments

1. F 584 and 585 (N.G.) Rectangular grid over all of fragments

1st. degree

C1 = .638543 + 03
C2 = -.775571 - 01
C3 = .122265 - 01

r = .9471
S = 1.43
N = 235

2nd. degree

C4 = .671578 + 04
C5 = -.382776 + 01
C6 = .422071 + 01
C7 = .264511 - 04
C8 = -.169145 - 02
C9 = .101328 - 02

r = .9573
S = 1.29

2. F 584 and 585 (R) Distorted rectangular grid over all of fragments

1st. degree

C1 = .145091 + 03
C2 = -.446904 - 00
C3 = .351209 - 00

r = .9446
S = 1.47
N = 235

2nd. degree

C4 = .147507 + 03
C5 = -.854481 - 00
C6 = .104981 + 01
C7 = .102747 - 01
C8 = -.678270 - 01
C9 = -.108266 - 01

r = .9731
S = 1.03

3. F 584 and 586/588 (N.G.) Rectangular grid all over fragments

1st. degree

C1 = -.325878 + 03

2nd. degree

C4 = -.189829 + 06

C2 = -.975789 - 01	C5 = .290699 + 02
C3 = .340530 - 00	C6 = .519518 + 02
	C7 = -.170880 - 02
	C8 = -.610791 - 02
	C9 = -.150506 - 02
r = .7960	r = .8636
S = 3.24	S = 2.70
N = 106	

4. F 584 and 586/588 (R) Distorted rectangular grid

1st. degree	2nd. degree
C1 = .106205 + 03	C4 = .582125 + 02
C2 = .333467 - 00	C5 = .216116 + 01
C3 = .271302 + 01	C6 = .122914 + 02
	C7 = -.122342 - 01
	C8 = -.259898 - 00
	C9 = -.243786 - 00
r = .8252	r = .8666
S = 3.06	S = 2.70
N = 106	

5. F 585 and 586/588 (N.G.) Rectangular grid all over fragments

1st. degree	2nd. degree
C1 = .103615 + 04	C4 = -.126031 + 05
C2 = -.151326 - 00	C5 = .102719 + 02
C3 = .464883 - 01	C6 = -.135755 + 02
	C7 = -.686071 - 03
	C8 = .230182 - 02
	C9 = -.251740 - 03
r = .9381	r = .9569
S = 2.73	S = 2.29
N = 225	

6. F 585 and 586/588 (R) Distorted rectangular grid

1st. degree	2nd. degree
C1 = .150458 + 03	C4 = .146332 + 03

C2 = -.915558 - 00
C3 = .288507 - 00

r = .9403
S = 2.69
N = 225

C5 = -.396535 - 00
C6 = .691950 - 00
C7 = -.901318 - 02
C8 = .187844 - 00
C9 = -.887256 - 01

r = .9542
S = 2.36

C. Comparison of trend surface results.

Surfaces	order	V1	V2	F	M
A1 and A4	1	2	171	270.5	38
	2			339.2	48
A1 and A11	1	2	171	1128.5	157
	2			1161.8	231
A1 and B1	1	2	171	12.9	2
	2			3.3	
A1 and B3	1	2	171	13.1	2
	2			14.4	2
A2 and A5	1	2	171	190.5	27
	2			119.5	17
A2 and A12	1	2	171	930.8	129
	2			2009.8	279
A2 and B2	1	2	171	16.6	3
	2			11.9	2
A3 and A4	1	2	174	27.1	4
	2			0.7	
A4 and A1	1	2	528	58.6	9
	2			767.7	107
A4 and A3	1	2	528	74.4	11
	2			7.9	2
A4 and A11	1	2	528	5658.1	786
	2			812.9	113
A4 and B1	1	2	528	3.1	
	2			0.3	
A5 and A2	1	2	528	12.4	2
	2			849.9	119

A5 and A6	1	2	528	138.1	20
	2			155.8	22
A5 and A7	1	2	528	59.4	9
	2			52.9	8
A5 and A12	1	2	528	5917.5	822
	2			1782.7	248
A5 and B2	1	2	528	24.0	4
	2			58.5	9
A6 and A5	1	2	252	28.5	4
	2			32.4	5
A6 and A7	1	2	252	142.1	20
	2			103.2	15
A7 and A5	1	2	273	26.5	4
	2			30.1	5
A7 and A6	1	2	273	205.9	29
	2			259.8	36
A8 and A9	1	2	432	0.0	
	2			0.4	
A8 and A10	1	2	432	1.2	
	2			11.7	2
A9 and A8	1	2	171	1.0	
	2			0.9	
A9 and A10	1	2	171	2.7	
	2			0.9	
A10 and A8	1	2	267	0.8	
	2			33.1	5
A10 and A9	1	2	267	0.7	
	2			29.1	4

A11 and A1	1	2	141	2663.1	370
	2			3059.4	480
A11 and A4	1	2	141	1443.0	200
	2			3459.1	480
A11 and B3	1	2	141	39.4	6
	2			20.2	3
A12 and A2	1	2	141	2401.8	333
	2			3395.0	472
A12 and A5	1	2	141	877.3	122
	2			3185.0	442
A12 and B4	1	2	141	43.5	6
	2			12.0	2
B1 and A1	1	2	702	53.1	8
	2			468.7	66
B1 and A4	1	2	702	40.0	6
	2			80.5	12
B2 and A2	1	2	702	15.9	3
	2			172.5	24
B2 and A5	1	2	702	103.2	15
	2			38.9	6
B3 and A1	1	2	315	155.3	22
	2			182.5	26
B3 and A11	1	2	315	122.4	17
	2			124.8	18
B4 and A12	1	2	315	171.5	24
	2			188.6	27

APPENDIX 4

SEISMIC REFRACTION TRAVERSE DATA

The results of 62 seismic refraction traverses and the interpretations derived from inspection of this data and, where possible, a comparison with boreholes or exposed sections, are tabulated overleaf. A number of abbreviations have been employed in these tables and these are defined as follows:

Set	an identification number
T	traverse type, either F (forward) or B (back or reverse)
Grid Ref.	National Grid reference of the geophone position
V_1-V_4	Seismic wave velocities of the materials in layers 1-4, in feet/second
C_1-C_3	critical distances to inflexion points on graph from geophone positions, in feet
D_1-D_3	depths to seismically significant interfaces from the geophone position, in feet
S	sand
G	gravel
T	till
R	rock
?	questionable interpretation
-	most likely interpretation
*	velocity lines on graph discontinuous (Chapter 4)
A	velocity value for bedrock or critical distance assumed (on the basis of surrounding bedrock velocity values) in order to calculate M, the minimum thickness of drift.

In certain cases, alternative interpretations are possible but have not been included. The surface layer, for example, may consist of weathered till over unweathered till rather than the S&G/T nature suggested in some cases. Likewise the water content of sand may change vertically and the S/S&G nature suggested may be due to sand above and below the water table.

Depths to the seismically significant interfaces were calculated using the following standard formulae:

$$D1 = C1 \times K1$$

$$D2 = C2 \times K2 + D1 \times Q$$

where

$$K1 = \frac{1}{2} \times \sqrt{\frac{V2 - V1}{V2 + V1}}$$

$$K2 = \frac{1}{2} \times \sqrt{\frac{V3 - V2}{V3 + V2}}$$

$$Q = 1 - \frac{V2\sqrt{V3^2 - V1^2} - V3\sqrt{V2^2 - V1^2}}{V1\sqrt{V3^2 - V2^2}}$$

Set	T	Grid Ref.	V1	V2	V3	V4	C1	C2	C3	D1	D2	D3	Interpretation
FRUID													
1	F	0857 2297	800	4600			9			1.6			Peat/GorT?
KINGLEDORES													
2	F	1060 2822	2300	8500			70			26.6			G/TorR
3	B	1066 2824	2600	6000			72			22.6			
4	F	1072 2825	2900	6000	21,000		81.5	177.5		24.0	84.5		G/TorR/R
5	F	1082 2829	3400	9000	19,000		88	128		33.9	65.9		G/TorR/R
6	B	1087 2831	2400	6100	20,000		57	117		18.6	57.6		
7	F	1078 2827	2460	8100			69			25.2			G/R
8	B	1078 2827	2450	8700			66			24.8			
SHERIFMUIR													
9	F	1988 3992	1050	1890	2,700	9000	9.5	37.5	167	2.5	9.9	68	S/S&G/S&G/TorR
10	B	1993 3994	1600	2400	2,850	5900	15.5	41	177	3.5	9.8	56	
11	F	2000 3996	1270	2900	3,500		10	135		3.1	28.3		S/S&G
12	B	2005 3997	2800	3400			130			24.7			
13	F	2013 3998	2000	2900	14,000		14	158		3.1	65.9		S/S&G/R
14	B	2019 3999	900	3100	10,000		13	160		4.9	62.6		

15	F	2052	4002	1700	2500	7,100		10.5	123		2.3	43.9		
16	B	2048	4007	1620	2400	5,100	8500	27	92	159	5.9	31.4	65	S/S&G/T/R?
17	F	2042	4010	1280	2500	10,500		10	109		2.8	44.8		S/S&G/R
18	B	2035	4013	1050	2400	6,100		12.5	92		3.9	33.5		
19	F	2031	4016	1300	2640	8,100		10	133		2.9	50.1		S/S&G/TorR?
20	B	2026	4020	1140	2240	3,900		10	79		2.8	22.4		
21	F	2007	4034	1200	2000	3,300		33	145		8.1	41.3		S/S&G/?
22	B	2004	4029	600	2150	20,000		5	112		1.9	43.6		
23	F	2002	4024	1000	2200	8,000		20	24		6.1	52.2		S/S&G/R
24	B	1999	4017	1200	2000	10,300		126	137		6.0	60.2		
25	F	2020	4027	1850	15000			98			43.4			S&G/R
26	B	2015	4022	2450	15000A			200A			85M			
27	F	1998	4030	1340	2750	15,000?		29	114		8.4	53.5		S/S&G/R
28	B	1993	4033	1050	2410	15,000		22	61		7.1	31.4		
29	F	1991	4034	800	2800	16,000		14	69		5.2	33.2		S/S&G/R
30	B	1984	4036	850	7800	13,500		18	175		8.1	52.3		
CADEMUIR														
31	F	2210	3643	1600	4000	6,200		21	76		7.9	24.1		S/T/R?
32	B	2216	3645	1080	6000	10,000		23	126		9.6	39.8		

33	F	2415	3680	600	7000*		16				S/T?
34	B	2417	3674	1200	5500*		15				
35	F	2525	3775	2300	6000	10,000A	23	200A	7.7	56.8M	S&G/T?/(R)
36	B	2526	3782	1400	8500	10,000A	17	200A	7.2	42M	
ST. BOSWELLS BRIDGE											
37	F	6081	3239	1150	3500	7,800	10	48	3.6	18	S/T/R
38	B	6084	3234	1300	2500	6,600	10	23	2.8	10.5	
39	F	6093	3205	1180	10500		37		16.6		S/R
40	B	6093	3205	1000	7900		32		14.1		
41	F	6087	3200	1300	4600		21		7.9		S&G/T?
42	B	6087	3200	1800	4800		25		8.4		
43	F	6083	3196	2100	8900		20.5		8.1		S&G/R
44	B	6083	3196	1600	8000		16		6.5		
FLEURS CASTLE											
45	F	7080	3425	930	1910	6,200	15	32.5	4.4	15.2	S/S&G/T?
46	B	7084	3422	900	5710	10,000	24	133	11.4	45.0	S/T?/R
47	F	7092	3417	950	10000		33		15.0		S/R
48	B	7079	3414	1100	6200*		36		15.0		
49	F	7103	3413	1120	5600	14,000	26	87	10.6	38.4	S/R?/R
50	B	7109	3410	1000	9500	19,000	32	106	14.4	43.7	

51	F	7118	3403	1170	10000		36		16.0		
52	B	7123	3399	1100	10600		35.5		16.0		S/R
REDDON											
53	F	7791	3696	500	8600		12		5.7		
54	B	7788	3701	500	8100		9.5		4.5		S/R
55	F	7776	3720	1140	7500		21		9.0		S/R?
56	B	7773	3725	680	2400	7,000	8	14	3.0	7.5	S/S&G/R?
TWEEDMOUTH											
57	F	NU 0010	5300	1520	7000*		60		24.0		
58	B	NU 0005	5301	1130	10000		37.5		16.7		S&G/R
59	F	NU 0014	5308	870	1710	6,000	16	59	4.5	23.2	S/S&G/R?
60	B	NU 0011	5309	1450	8000		56		25.4		S&G/R?
61	F	NU 0007	5295	600	1600	14,000	10	53	3.4	26.4	
62	B	NU 0002	5297	900	1400	8,000	17	40	4.0	19.4	S/S&G/R

Appendix 5 Stone Counts.

The symbols O.R.S. and Carb. refer to rocks of Old Red Sandstone and Carboniferous age respectively.

a) Five Mile Bridge (NT 1849 4066), 100 stone sample.

1	Lava, probably O.R.S.
10	Felsites (O.R.S.)
2	Agglomerates, probably O.R.S.
3	Coarse sandstone conglomerates, probably O.R.S.
4	Banded sandstones, probably O.R.S. or Carb.
25	Purple dyke rocks, probably O.R.S.
44	Unweathered and highly weathered greywackes
I	Unidentifiable
Total 100	

Summary: 55% O.R.S. or Carb., 44% pre - O.R.S.

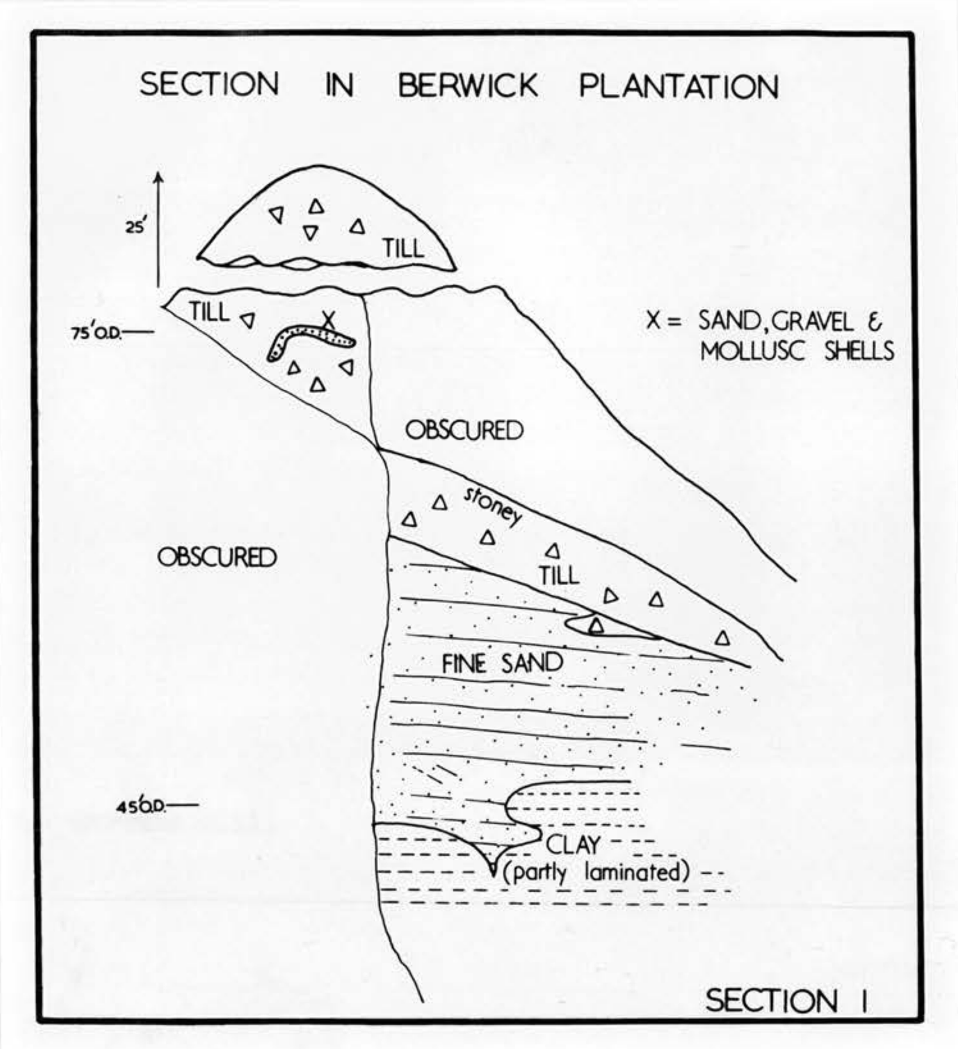
b) Hallyne esker (NT 1906 4057), 100 stone sample.

3	Purple vesicled dyke rocks, probably O.R.S.
9	Felsites (O.R.S.)
6	Vein quartz, 1 with Jasper.
82	Greywackes or associated rocks
Total 100	

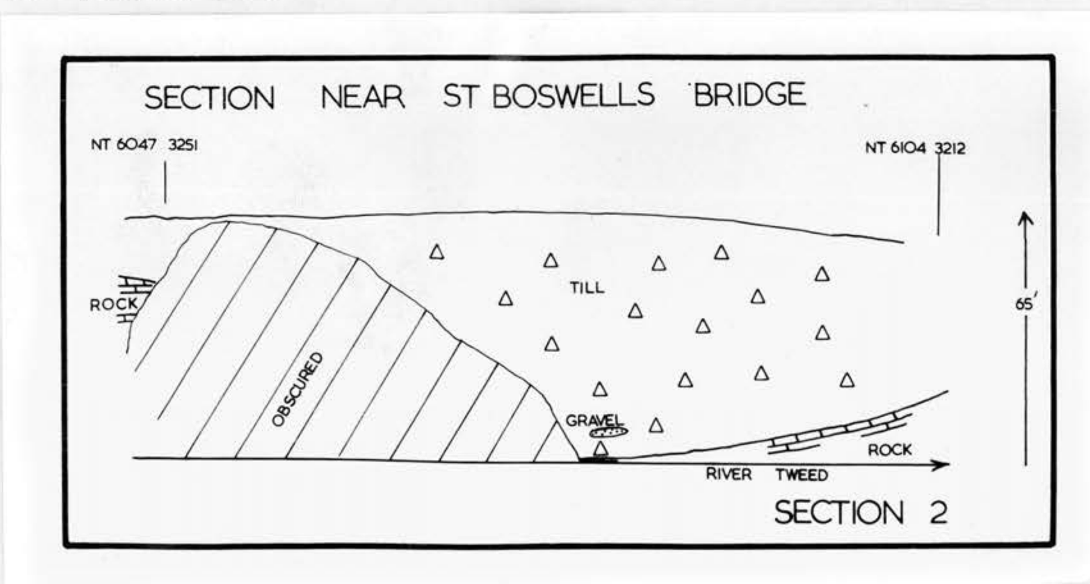
Summary: 12% O.R.S. or Carb., 82% pre - O.R.S.

Appendix 6: Relevant sections not described in the text.

1. Berwick on Tweed.



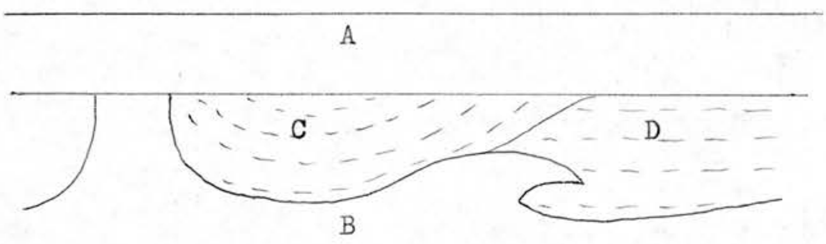
2. Mertoun Mill.



Section 3 | Location : NT 5660 3445

Brown silt with occasional boulders and no stratification (till)	c.60 feet
Sharp junction	
Horizontally bedded gravel in sand matrix	c.30 feet
River	

Section 4 | Location : Leithen Water (after J.Geikie 1894)



A: Upper till
B: Lower till
C: Stratified sands
D: Laminated clays.

Section 5 | Location : NT 9421 5230

Stoney till	20 feet
Fine sand	4 feet
Clay	unknown depth

Section 6 | Location : NT 9125 4900

Silt with stones	unknown thickness
Fine sand	c.10 feet
Silt	unknown thickness

Section 7 | Location : NT 9032 4800

Stoney silty clay, compact	c.40 feet?(Partly obscured)
Sharp junction	
Fine sand, in lens form	2 feet
Uneven junction	
Silty clay	unknown thickness

Section 8 | Location : NT 8849 4543

Small gravel	2 - 3 feet
Large gravel,up to 8 inches diameter	1.5 feet
Silty clay, with occasional stones	3 feet
Bedrock	

Section 9 Location : NT 8844 4515

Unstratified stoney silt 8 feet
Bedrock

Section 10 Location : NT 8758 4370

Drift 5 feet
Bedrock

Section 11 Location : NT 8654 4281

Large boulders 1 foot
Unstratified silty sand 6-8 feet
Micaceous purple sandstone

Section 12 Location : NT 8250 3858

Silt and stones
4 feet

Subhorizontal gravel layer 4 feet

Section 13 Location : NT 7797 3860

Large rounded and subrounded
boulders in small gravel and
fine sand 6 feet
Obscured

Section 14 Location: NT 7566 3678

Drift 10 feet
Bedrock

Section 15 Location : NT 7455 3495

Silty clay 4 feet
Bedrock

Section 16 Location : NT 6895 3339

Fine sand 20 feet
Bedrock c,40 feet
River surface

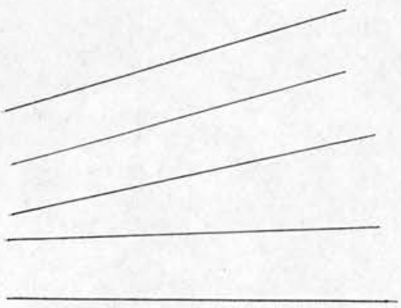
Section 17 Location : NT 6253 3146

Rounded stones in silt 3.5 feet
Red shale

Section 18 Location : NT 5585 3502

Red-brown stoney till	20-40 feet
Gravel	c.35 feet
Obscured	20-35 feet
River	

Section 19 Location : NT 522 360 (approx)



4-5 feet unbedded sub-angular material

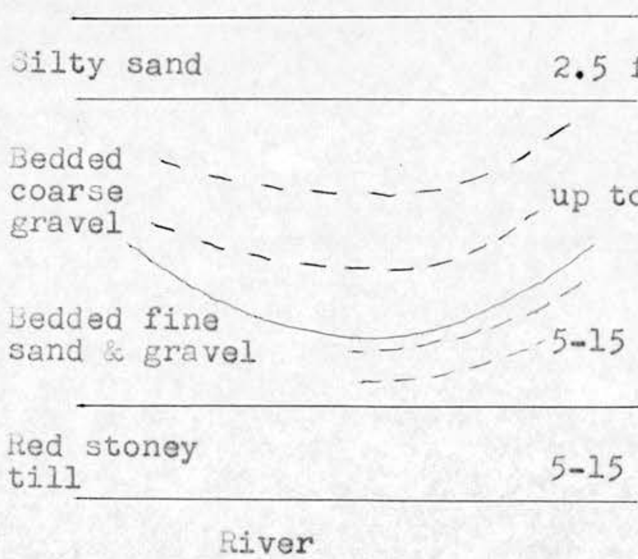
2 feet medium sand with gravel lenses

heterogeneous sized gravel

2 feet current bedded small gravel

Ripple marked fine sand and silt, base not exposed

Section 20 Location : NT 5117 3520



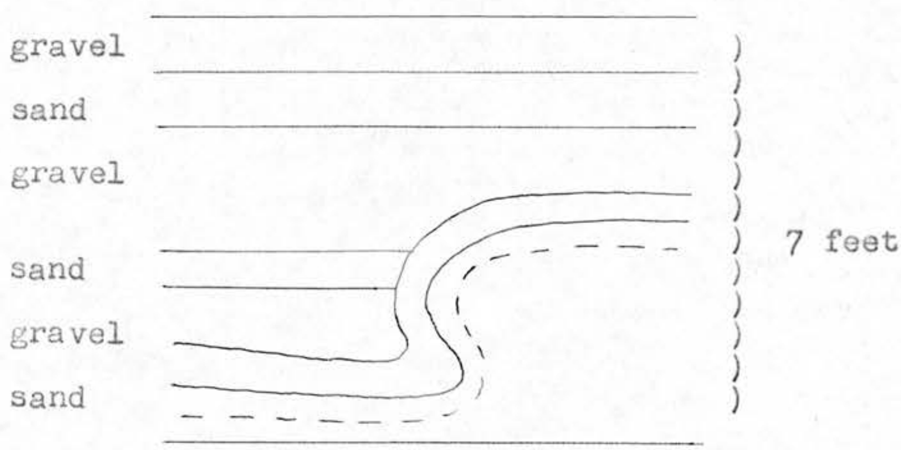
Section 21 Location : NT 3671 3722

F 350
Sand and gravel
(rudimentary horizontal bedding) 7 feet

Section 22 Location : NT 1750 4146

Sand and gravel 15 feet +
(horizontally bedded)

Section 23 Location : NT 1262 3093



grey silty loam with
few stones

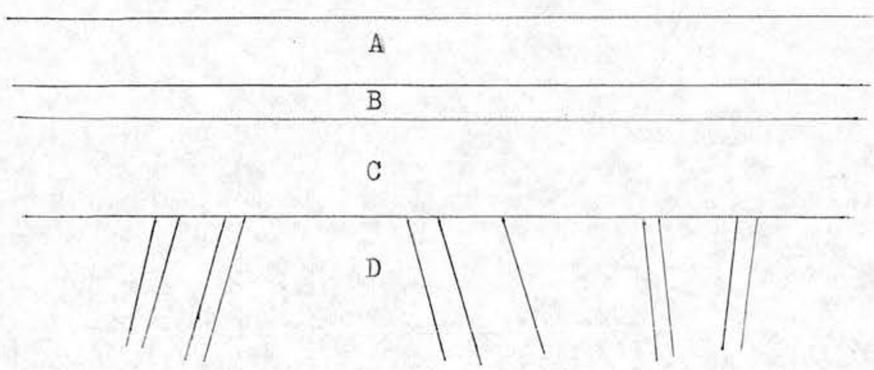
Section 24 Location : NT 1020 2790

Sand, gravel, angular stones
and boulders 35 feet
Stream

Section 25 Location : NT 1095 2558

Stoneless silt 1-3 feet
Large gravel and boulders 6 feet
River

Section 26 Location : NT 1012 2477



A: Horizontal layer of silt with a few rounded and many angular stones. 1-3 feet thick
B: Horizontal layer of stoneless silt 1.5 feet thick
C: Horizontal layer and horizontally bedded large gravel, cobbles and boulders in a sand matrix. 5 feet thick
D: Steeply dipping and truncated beds of sand and gravel, varying in coarseness 6-7 feet exposed
River

Section 27 **Location** : NT 0555 1797

Peat	1-2 feet
Frost shattered pebbles	2 feet
Brown silty clay, incorporating thin gravel and sand layers	10 feet

Appendix 7. Pollen Counts.

Arboreal Pollen.	Sample 3.	Sample 1.
Pinus	1	1
Betula	16	12
Alnus	12	12
Ulmus	-	-
Quercus	2	1
Tilia	-	1
Salix	1	-
Corylus	17	15

Non-Arboreal Pollen and Spores.	Sample 3.	Sample 1.
Cyperaceae	34	8
Gramineae	66	37
Ericaceae	70	138
Filicales	2	4
Sphagnum	16	16
Filipendula	2	-
Plantago	1	-
Rumex	2	-
Cereal ?	1	-
Pteridium	2	-
Umberliferae	-	2
	Sample 3 composed largely of Sphagnum spp. fragments	Very dark well humified peat. No recognisable macro-flora

Appendix 8: Computer Programs in Atlas Autocode.

Note: Some of the symbols shown overleaf are peculiar to the EBCDIC card punching system on IBM 029 punches. The % sign, for example, replaces the underlining symbol commonly used on Flexowriters.

CORREG II

```
% BEGIN
  % LIST
  % REALARRAY X,Y(1:1000)
  % REAL SX,SY,SX2,SY2,SXB2,SYB2,SXY,A,B,R,STD, ERROR,C
  % REAL STD DEVN,A2,A3,A4,A5,B2,B3,B4,B5
  % INTEGER N,I,E,D,N2,N3,N4,N5,F,P  ,G,H,J,K  ,L
  % ROUTINESPEC REFERENCE
  L = 1
  G = 2
  H = 3
  J = 4
  K = 5
47:  N=0;  SX=0;  SY=0;  SX2=0;  SY2=0;  SXY=0;  SXB2=0;  SYB2=0
  % CYCLE  I=1,1,1000
  X(I)=0;  Y(I)=0
  % REPEAT
  % CYCLE  I=1,1,1000
1:  READ  (X(I),Y(I))
17:  % IF X(I) <0 %THEN REFERENCE
13:  -> 6 %IF X(I) <0
  SX=SX+X(I)
  SX2=SX2+X(I)* *2
  SY=SY+Y(I)
  SY2=SY2+Y(I)* *2
  SXY=SXY+(X(I)*Y(I))
  N=N+1
  % REPEAT
6:  SXB2=SX* *2
  SYB2=SY* *2
  R=((N*SXY)-(SX*SY))/SQRT((N*SX2-SXB2)(N*SY2-SYB2))
  B=((SX*SY)-(N *SXY))/(SXB2-(N *SX2))
  A=(SY-(B*SX))/N
  STD ERROR = SQRT  (MOD((SY2-((A*SY)+(B*SXY)))/2))
  NEWLINES  (5)
  % CAPTION FOR GENERAL EQUATION OF FORM Y=BX+A,  A=
  PRINT  (A,4,2)
  NEWLINE
  % CAPTION B=
  PRINT  (B,4,2)
  NEWLINES  (2)
  % CAPTION CORRELATION COEFFICIENT, R=
  PRINT  (R,1,4)
  NEWLINES  (2)
  % CAPTION COEFFICIENT OF DETERMINATION, D=
  PRINT  (R* *2,1,4)
  NEWLINES  (2)
  % CAPTION NUMBER OF TERMS, N=
  WRITE  (N,4)
  NEWLINES  (2)
  % CAPTION   STD ERROR=
  PRINT  (STD ERROR,5,3)
  NEWLINES  (5)
  SX=0;  SY=0;  SX2=0;  SY2=0;  SXB2=0;  SYB2=0;  SXY=0;  P=0
  N2=INTPT(N/2) *G -1
  %FAULT 3 -> 38
```

```
 % CYCLE I=L,2,N2
 SX=SX+ X(I)
 SY=SY+Y(I)
 SX2=SX2+X(I)* *2
 SY2=SY2+Y(I)* *2
 P=P+1
 SXY=SXY+(X(I)*Y(I))
 % REPEAT
 SXB2=SX* *2
 SYB2=SY* *2
 % FAULT 1 → 38
 R=((P *SXY)-(SX*WY))/SQRT((P *SX2-SXB2)(P *SY2-SYB2))
B2=((SX*SY)-(P*SXY))/(SXB2-(P*SX2))
 A2=(SY-(B2*SX))/P
 STD ERROR = SQRT(MOD((SY2-((A2*SY)+(B2*SXY)))/2))
 % CAPTION FOR GENERAL EQUATION OF FORM Y=B2 X+A2,A2=
 PRINT (A2,4,2)
 NEWLINES (2)
 % CAPTION B2=
 PRINT (B2,4,2)
 NEWLINES (2)
 % CAPTION CORRELATION COEFFICIENT,R=
 PRINT (R,2,4)
 NEWLINES (2)
 % CAPTION COEFFICIENT OF DETERMINATION,D=
 PRINT (R**2,1,4)
 NEWLINES (2)
 % CAPTION STANDARD ERROR OF ESTIMATE=
 PRINT (STD ERROR    ,4,3)
 NEWLINES (2)
 % CAPTION NUMBER OF TERMS, P= SPACES (10) N=
 WRITE (P,4): SPACES(10); WRITE(N ,4)
 NEWLINES (2)
 % CAPTION % VARIATION OF A=  ; PRINT (MOD(100*(A2-A)/A),4,2)
 % CAPTION % VARIATION OF B=  ; PRINT (MOD(100*(B2-B)/B),4,2)
 NEWLINES (5)
38: SX=0; SY=0; SX2=0; SXB2=0; SYB2=0; SXY=0; E=0; SY2=0
N3=INTPT (N/3)   *H   -2
 % FAULT 3 → 37
 % CYCLE I=L,3,N3
 SX=SX+ X(I)
 SY=SY+Y(I)
 SX2=SX2+X(I)**2
 SY2=SY2+Y(I)**2
 E=E+1
 SXY=SXY+(X(I)*Y(I))
 % REPEAT
 SXB2=SX**2
 % FAULT 1→37
 B3=((SX*SY)-(E *SXY))/(SXB2-(E *SX2))
 A3=(SY-(B3*SX))/E
 STD ERROR = SQRT (MOD((SY2-((A3*  SY)+(B3* SXY)))/2))
 R=((E *SXY)-(SX*SY))/SQRT((E *SX2-SXB2)(E *SY2-SYB2))
 % CAPTION N =    E=
 WRITE (N ,3); SPACES (10); WRITE (E,3)
 % CAPTION FOR GENERAL EQUATION OF FORM Y=B3X+A3,B3=
 PRINT (B3,4,2)
 NEWLINES (2)
 % CAPTION A3=
```

```
     PRINT(A3,4,2)
     NEWLINES (2)
     % CAPTION CORRELATION COEFFICIENT,R=
     PRINT (R,2,4)
     NEWLINES (2)
     % CAPTION COEFFICIENT OF DETERMINATION,D=
     PRINT (R**2,1,4)
     NEWLINES (2)
     % CAPTION  STD ERROR=
     PRINT (STD ERROR,4,3)
     NEWLINES (2)
     % CAPTION % VARIATION OF A=;PRINT(MOD(100*(A3-A)/A),4,2)
     % CAPTION % VARIATION OF B=;PRINT(MOD(100*(B3-B)/B),4,2)
     NEWLINES (5)
37:  SX=0;  SY=0;  SX2=0;  SXB2=0;  SYB2=0;  SY2=0;  SXY=0;  D=0
    N4=INTPT(N/4)  *J -3
     % FAULT 3 -> 36
     % CYCLE I=L,4,N4
     SX=SX+ X(I)
     SY=SY+Y(I)
     SX2=SX2+X(I)**2
     SY2=SY2+Y(I)**2
     D=D+1
     SXY=SXY+(X(I)*Y(I))
     % REPEAT
     SXB2=SX**2
     SYB2=SY**2
     % FAULT 1 -> 36
     R=((D *SXY)-(SX*SY))/SQRT((D *SX2-SXB2)(D *SY2-SYB2))
    B4=((SX*SY)-(D*SXY))/(SXB2-(D*SX2)
     A4=(SY-(B4*SX))/D
     STD ERROR = SQRT(MOD((SY2-((A4*SY)+(B4* SXY)))/2))
     % CAPTION FOR GENERAL EQUATION%U OF FORM Y=B4X+A4,B4=
     PRINT (B4,4,2)
     NEWLINES (5)
     % CAPTION A4=
     PRINT (A4,4,2)
     NEWLINES (5)
     % CAPTION CORRELATION COEFFICIENT,R=
     PRINT (R,2,4)
     NEWLINES (5)
     % CAPTION COEFFICIENT OF DETERMINATION,D=
     PRINT (R**2,2,4)
     NEWLINES (5)
    % CAPTION NO OF TERMS, D=
     WRITE (D,3)
     NEWLINES (3)
     % CAPTION STD ERROR=
     PRINT (STD ERROR,4,3)
     NEWLINES (2)
     % CAPTION % VARIATION OF A=; PRINT(MOD(100*(A4-A)/A),4,2)
     % CAPTION % VARIATION OF B=; PRINT(MOD(100*(B4_B)/B),4,2)
     NEWLINES (8)
36:  SX=0;  SY=0;  SX2=0;  SXB2=0;  SYB2=0;  SY2=0;  SXY=0
     F=0
    N5=INTPT(N/5)  *K -4
     % FAULT 3 -> 39
     % CYCLE I=L,5,N5
```

```
SX=SX+ X(I)
SY=SY+Y(I)
SX2=SX2+X(I)**2
SY2=SY2+Y(I)**2
F=F+1
SXY=SXY+(X(I)*Y(I))
% REPEAT
SXB2=SX**2
SYB2=SY**2
% FAULT 1-->39
R=((F  *SXY)-(SX*SY))/SQRT((F  *SX2-SXB2)(F  *SY2-SYB2))
B5=((SX*SY)-(F*SXY))/(SXB2-(F*SX2))
A5=(SY-(B5*SX))/F
STD ERROR = SQRT(MOD((SY2-((A5*SY)+(B5*SXY)))/2))
% CAPTION FOR GENERAL EQUATION OF FORM Y=B5+A5,B5=
PRINT(B5,4,2)
NEWLINES (2)
% CAPTION A5=
PRINT(A5,4,2)
NEWLINES (2)
% CAPTION CORRELATION COEFFICIENT,R=
PRINT (R,2,4)
NEWLINES (2)
% CAPTION COEFFICIENT OF DETERMINATION,D=
PRINT (R**2,2,4)
NEWLINES (2)
% CAPTION F=  N=
WRITE (F,3);  SPACES(10); WRITTEN ,3)
NEWLINES (2)
% CAPTION STD ERROR=
PRINT (STD ERROR,4,3)
NEWLINES (2)
% CAPTION  % VARIATION OF A= ; PRINT(MOD(100*(A5-A)/A),4,2)
% CAPTION  % VARIATION OF B= ; PRINT(MOD(100*(B5-B)/B),4,2)
NEWLINES (5)
39: % CAPTION B2-B=
PRINT((MOD(B2)-MOD(B)),3,2)
NEWLINE
% CAPTION B3-B=
PRINT((MOD(B3)-MOD(B)),3,2)
NEWLINE
% CAPTION B4-B=
PRINT((MOD(B4)-MOD(B)),3,2)
NEWLINE
% CAPTION B5-B=
PRINT((MOD(B5)-MOD(B)),3,2)
NEWLINE
% CAPTION  A2-A=
PRINT((MOD(A2)-MOD(A)),3,2)
NEWLINE
% CAPTION  A3-A=
PRINT((MOD(A3)-MOD(A)),3,2)
NEWLINE
% CAPTION  A4-A=
PRINT((MOD(A4)-MOD(A)),3,2)
NEWLINE
% CAPTION  A5-A=
PRINT((MOD(A5)-MOD(A)),3,2)
NEWLINES (8)
```

→ 47

```
% ROUTINE REFERENCE

    NEWLINES (5)
    % CAPTION RESULTS-FOR-TERRACE-NUMBER;  SPACE
    PRINT(-X(I),4,0);  SPACE
    % CAPTION
    NEWLINES (5)
    % END

% ENDOFPROGRAM
```

F - CAL

```
% BEGIN

      % LIST
      % REAL C1,C2,C3,C4,C5,C6,C7,C8,C9,SRA1,SRA2,SRASQ1,SRASQ2,SRC1,
SRC2,SD1,SD2,SRCSQ1,SRCSQ2,SDSQ1    ,SDSQ2,SEX,RAPE,F,V1,V2,R,K,E,PQ
      % REALARRAY VAL(1:12), MEAN,STANDEV(1:4),,G(1:400)
      % REALARRAY A,X,Y,Z,ZT1,ZT2,ZTC1,ZTC2,RA1,RA2,RC1,RC2,D1,D2,D2(1:400)
      % INTEGER 1,N,L,P,M,J
      % INTEGERARRAY SCORE(1:12)
      % ROUTINESPEC HISTOGRAM
1:    SRA1=0;SRA2=0;SRASQ1=0;SRASQ2=0;SRC1=0;SRC2=0;SD1=0;SD2=0:
SRCSQ1=0;SRCSQ2=0;N=0  :SDSQ1=0:S   DSQ2=0
      READ(PQ,N,C1,C2,C3,C4,C5,C6,C7,C8,C9)
      % COMMENT X,Y & Z ARE COORDINATES OF POINTS ON TERRACE A
      % COMMENT        PQ=1  WHEN G IS PRESENT
    %1F   PQ= 1%THEN → 12
      % CYCLE I =1,1,N
      READ (    X(I),Y(I),Z(I))
     % REPEAT
  → 4
12:  %CYCLE I=1,1,N
     READ (G(I),X(I), Y(I),Z(I))
     %REPEAT
4:   %CYCLE  I=1,1,N
      ZT1(I) = C1+C2*   X(I) + C3* Y(I)
      ZT2(1) = C4 + C5 * X(I) + C6*Y(I) + C7* X(I)**2+C8* Y(I)**2
+C9*X(I) * Y(I)
      RA1(I) = ZT1(I) -Z(I)
      RA2(I) = ZT2(I) -Z(I)
      %COMMENT RA IS RESIDUAL FROM 1 OR 2 ORDER SURFACES FITTED TO DATA
SET A
      SRA1 = SRA1 + RA1(I)
      SRA2 = SRA2 + RA2(I)
      SRASQ1 = SRASQ1 + RA1(I)**2
      SRASQ2 = SRASQ2 + RA2(I)**2
      %REPEAT
      MEAN(1) = SRA1 /N
      MEAN(2) = SRA2 /N
      STANDEV(1)=SQRT((SRASQ1 /N)-(SRA1 /N)**2)
      STANDEV(2) = SQRT((SRASQ2/N) - (SRA2/N)**2)
      %CYCLE P = 1,1,2
      %1F P = 1 %THEN A(I) = RA1(I)
      %1F P = 2 %THEN A(I) = RA2(I)
      HISTOGRAM
      % REPEAT
14:   READ(C1,C2,C3,C4,C5,C6,C7,C8,C9)
      % CYCLE I = 1,1,N
      ZTC1(I) = C1 + C2 *X(I) + C3*Y(I)
      ZTC2(I) = C4 + C5 *X(I) + C6*Y(I) + C7*X(I)**2 + C8*Y(I)**2 + C9
*X(I)*Y(I)
      RC1(I) = Z1C1(I) - Z(I)
      RC2(I) =ZTC2(I) - Z(I)
% COMMENT D = DIFFERENCE BETWEEN THEORETIC VALUES OF SURFACES A & C AT X,Y
      D1(I)=ZT1(I)-ZTC1(I)
      D2(I)=ZT2(I)-ZTC2(I)
      SRC1 = SRC1+RC1(I)
      SRC2 = SRC2+RC2(I)
```

```
      SD1 = SD1+D1(I)
      SD2 = SD2+D2(I)
      SRCSQ1 = SRCSQ1+RC1(I)**2
      SRCSQ2 = SRCSQ2+RC2(I)**2
      SDSQ1 = SDSQ1+ D1(I)**2
      SDSQ2 = SDSQ2+ D2(I)**2
      %REPEAT
      MEAN(1) = SRC1/N
      MEAN(2) = SRC2/N
      MEAN(3) = SD1/N
      MEAN(4) = SD2/N
      STANDEV(1) = SQRT((SRCSQ1 /N)-(SRC1/N)**2)
      STANDEV(2) = SQRT((SRCSQ2 /N)-(SRC2/N)**2)
      STANDEV(3) = SQRT((SDSQ1 /N)-(SD1/N)**2)
      STANDEV(4) = SQRT((SDSQ2 /N)-(SD2/N)**2)
      % CAPTION THE FIRST PAIR OF HISTOGRAMS REFER TO SURFACE C,
THE SECOND PAIR TO THE D VALUES
      NEWLINES(5)
      % CYCLE P = 1,1,4
      %IF P = 1 %THEN A(I) = RC1(I)
      %IF P = 2 %THEN A(I) = RC2(I)
      %IF P = 3 %THEN A(I) = D1(I)
      %IF P = 4 %THEN A(I) = D2(I)
      HISTOGRAM
      % REPEAT
      %COMMENT SEX = EST. VARIANCE BETWEEN COLUMN MEANS
      %COMMENT RAPE = EST. VARIANCE WITHIN COLUMNS
      %CYCLE M = 1,1,2
      K = ((SRA1**2)/N+(SRC1**2)/N + (SD1**2)/N)
      R = (SRASQ1 + SRCSQ1 + SDSQ1)
     SEX=(K-((SRA1+SRC1+SD1)*2)/(3*N))/2
      RAPE = (R-K)/(3*(N-1))
      F = SEX/RAPE
      NEWLINES(10)
      %CAPTION SEX=
      PRINT (SEX,7,2)
      NEWLINE
      %CAPTION RAPE=
      PRINT(RAPE,7,2)
      NEWLINE
      %CAPTION F =
      PRINT(F,3,2)
      NEWLINE
      %CAPTION V1=2
        NEWLINE
      %CAPTION V2=
      PRINT((3*(N-1)),3,0)
      NEWLINE
      %CAPTION TOTAL VARN.(SHOULD BE IDENTICAL) =
     PRINT(       (SEX*2)+RAPE*3*(N-1),5,2)
      NEWLINE
      PRINT((R-((SRA1+SRC1+SD1)**2)/(3*N)),9,2)
      NEWLINES(10)
      SRA1 = SRA2
      SRASQ1 = SRASQ2
      SRC1 = SRC2
      SRCSQ1 = SRCSQ2
      SD1 = SD2
      SDSQ1 = SDSQ2
```

```
%REPEAT
NEWPAGE
  ->1
%ROUTINE HISTOGRAM

  NEWLINES(5)
  %CAPTION NO. OF INDIVIDUALS
  PRINT (N,3,0);  NEWLINES(2)
  %CAPTION MEAN=
  PRINT(MEAN(P),5,1);  NEWLINES(2)
  %CAPTION STANDEV =
  PRINT(STANDEV(P),5,2);  NEWLINES(5)
  %CAPTION  HISTOGRAM FOR
  SPACES(3);  PRINT (P,1,0);  SPACES(2)
  %CAPTION ORDER SURFACE
 NEWLINES(8)
  E = MEAN(P)+  (STANDEV(P)*7/2)
  %CYCLE I = 1,1,12
  E=E-(STANDEV(P)/2)
  VAL(I)=E
  SCORE(I) =0
  %REPEAT
  %CYCLE I = 1,1,N
  %IF A(I)>VAL(2) %THEN SCORE  (1) = SCORE(1)+1
  %IF VAL(3) < A(I) < VAL(2)  %THEN SCORE (2)=SCORE(2)+1
  %IF VAL(4) < A(I) < VAL(3)  %THEN SCORE (3)=SCORE(3)+1
  %IF VAL(5) < A(I) < VAL(4)  %THEN SCORE (4)=SCORE(4)+1
  %IF VAL(6) < A(I) < VAL(5)  %THEN SCORE (5)=SCORE(5)+1
  %IF VAL(7) < A(I) < VAL(6)  %THEN SCORE (6)=SCORE(6)+1
  %IF VAL(8) < A(I) < VAL(7)  %THEN SCORE (7)=SCORE(7)+1
  %IF VAL(9) < A(I) < VAL(8)  %THEN SCORE (8)=SCORE(8)+1
  %IF VAL(10) < A(I) < VAL(9)  %THEN SCORE (9)=SCORE(9)+1
  %IF VAL(11) < A(I) < VAL(10)  %THEN SCORE (10)=SCORE(10)+1
  %IF VAL(12) < A(I) < VAL(11)  %THEN SCORE (11)=SCORE(11)+1
  %IF A(I) < VAL(12) %THEN SCORE (12)=SCORE(12)+1
  %REPEAT
  PRINT SYMBOL('+')
  NEWLINE
  %CYCLE I= 1,1,12
  %IF  SCORE(I) = 0 %THEN ->2
  %CYCLE J = 1,1,SCORE(I)
  %CAPTION *
  %REPEAT
2:  NEWLINE
  %REPEAT
  PRINT SYMBOL('+')
  NEWLINES(5)
  %END

%ENDOFPROGRAM
```